J. E. BLOOM.

ELECTRICAL TREATMENT IN THE COMPOUNDING OF SOLIDS WITH GASES, OR SOLIDS WITH SOLIDS AND GASES, INCLUDING FERTILIZERS, AND APPARATUS THEREFOR, AND THE PRODUCTS RESULTING THEREFROM.

APPLICATION FILED FEB. 6, 1920.

1,377,553. Patented May 10, 1921.

4 SHEETS—SHEET 1.

Fig-1

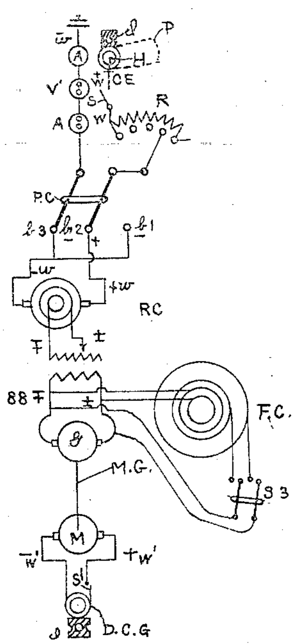


Fig-2

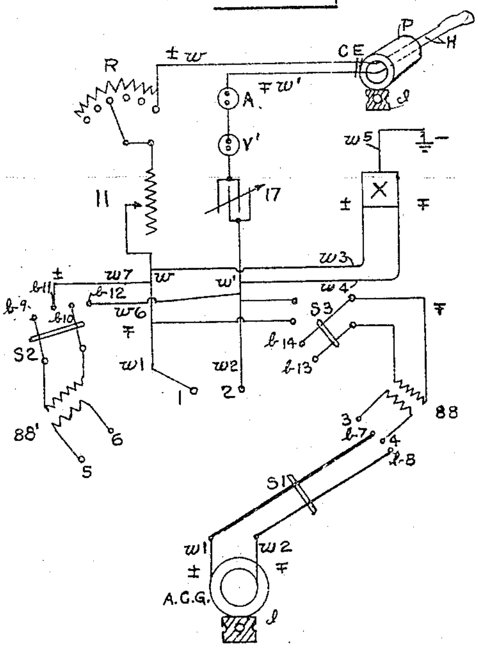
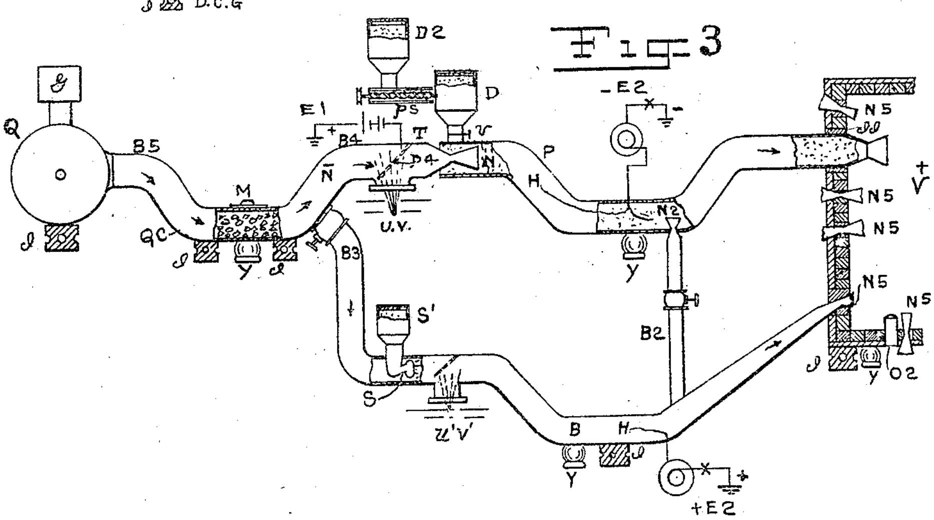


Fig-3



INVENTOR

Jacob E. Bloom

J. E. BLOOM.

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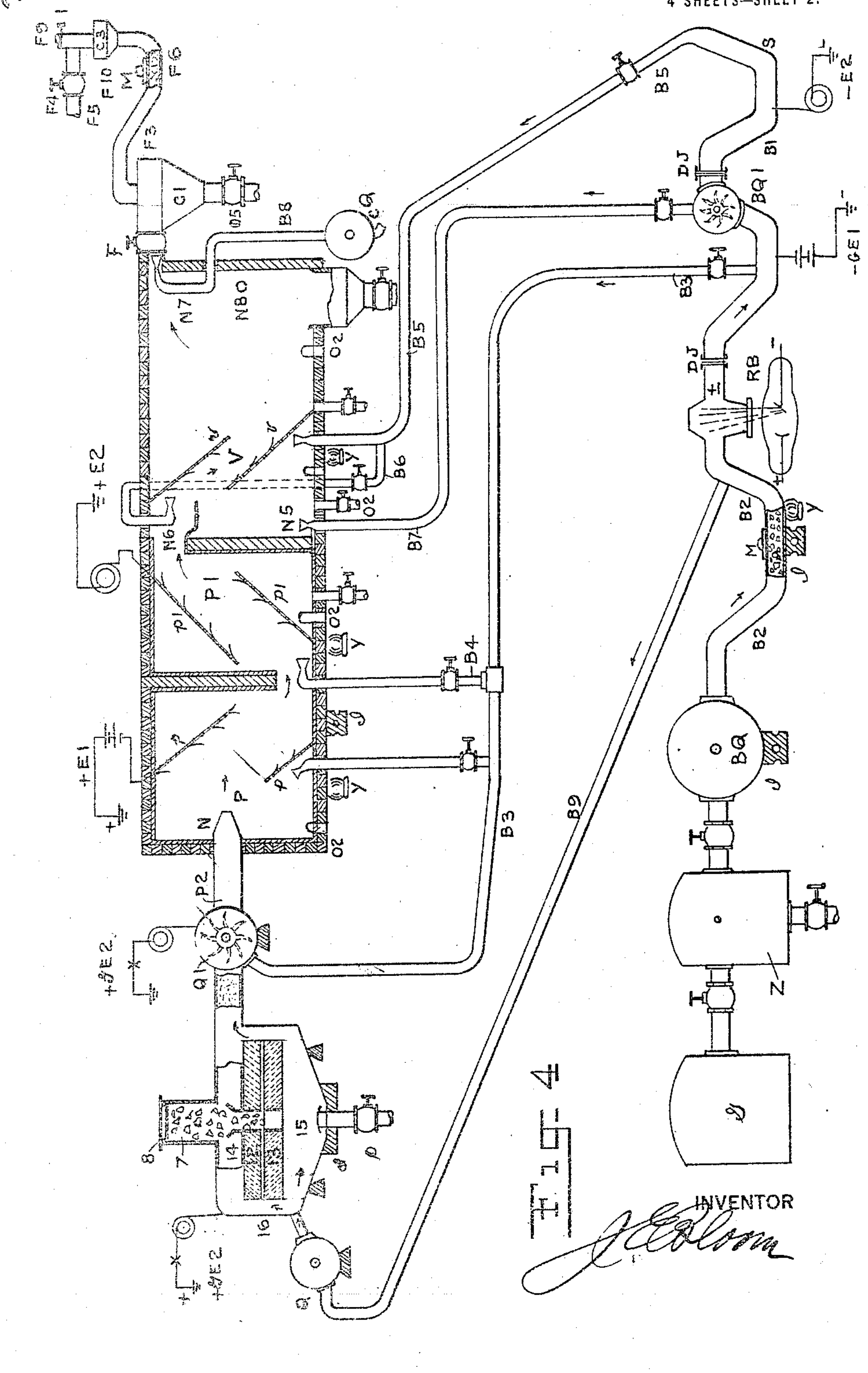
4 SHEETS—SHEET 2.



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4 SHEETS—SHEET 3.

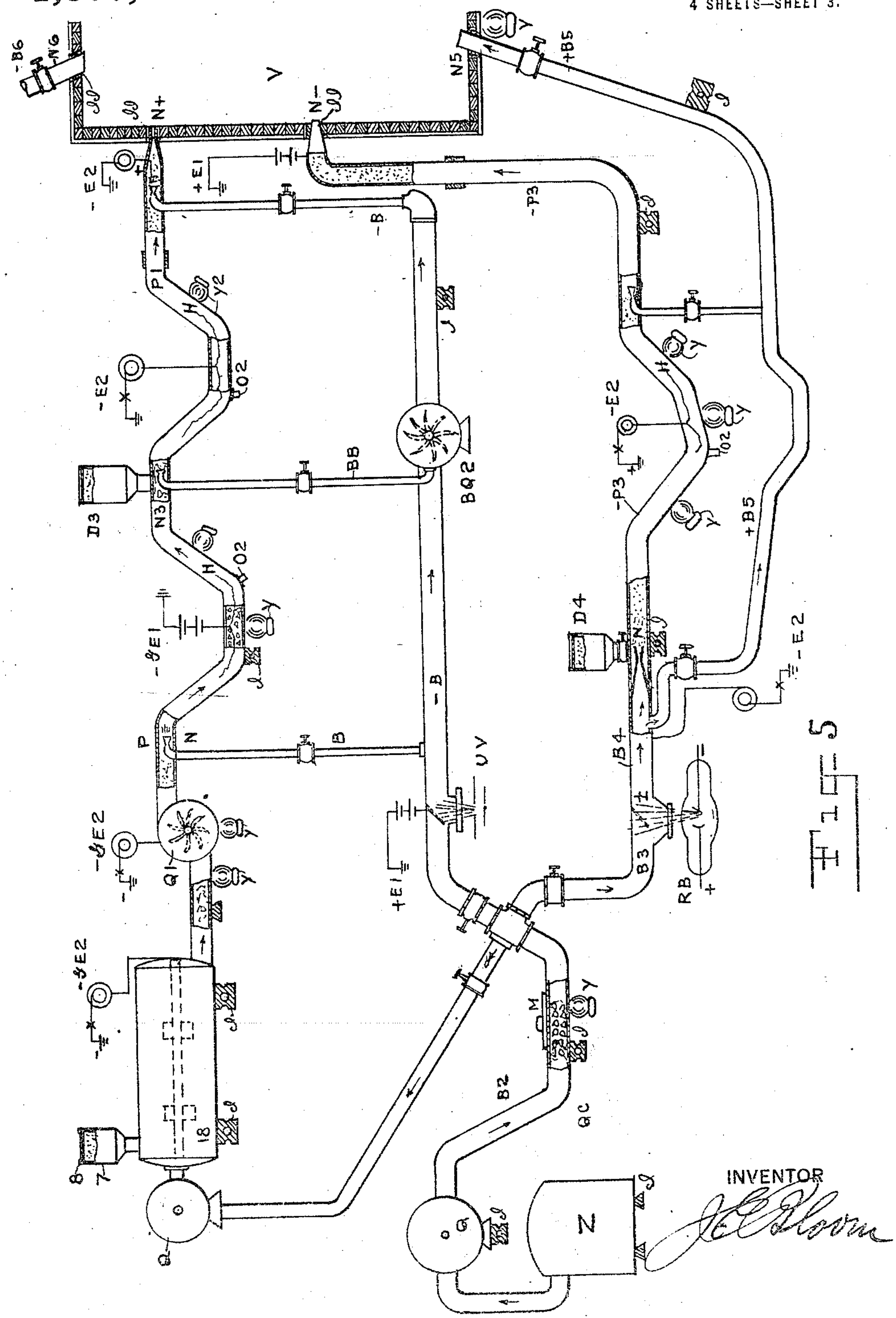

Fig. 5

INVENTOR
J. E. Bloom

J. E. BLOOM.

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1,377,553. APPLICATION FILED FEB. 6, 1920. Patented May 10, 1921.

4 SHEETS—SHEET 4.

Fig-6

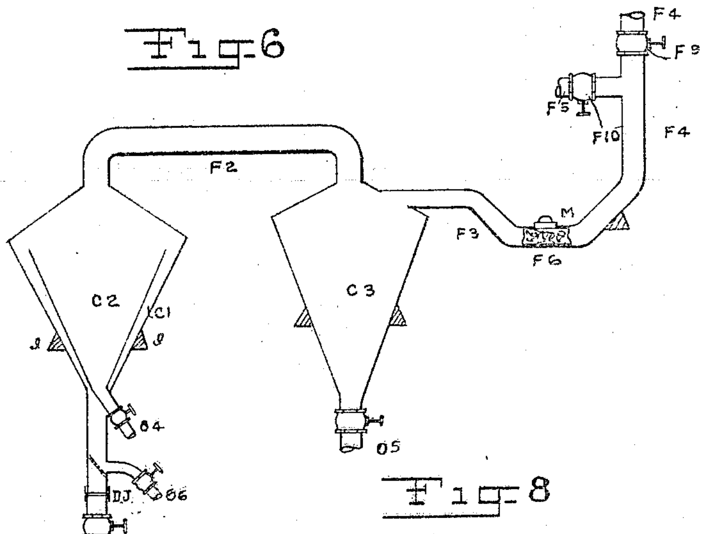
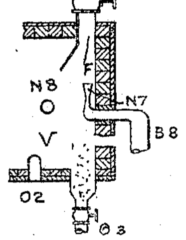



Fig-8

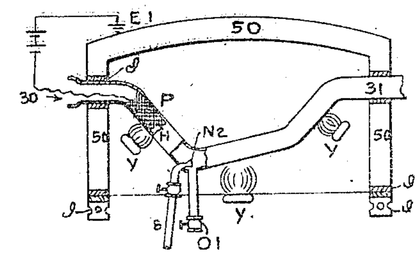


Fig-7

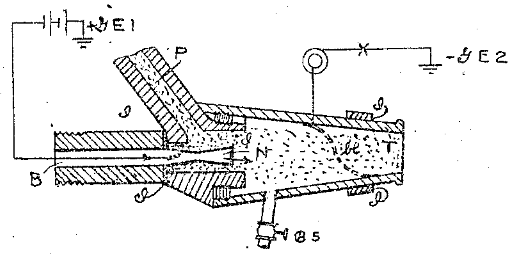
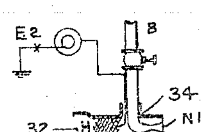


Fig-9



INVENTOR

Jacob E. Bloom

UNITED STATES PATENT OFFICE.

JACOB E. BLOOM, OF BROOKLYN, NEW YORK.

ELECTRICAL TREATMENT IN THE COMPOUNDING OF SOLIDS WITH GASES OR SOLIDS WITH SOLIDS AND GASES, INCLUDING FERTILIZERS, AND APPARATUS THEREFOR, AND THE PRODUCTS RESULTING THEREFROM.

1,377,553. Specification of Letters Patent. Patented May 10, 1921.

Application filed February 6, 1920. Serial No. 356,708.

To all whom it may concern:

Be it known that I, JACOB E. BLOOM, a citizen of the United States, residing at Brooklyn, city of New York, county of Kings, State of New York, have invented certain new and useful improvements in electrical treatments in the compounding of solids with gases or solids with solids and gases, including fertilizers, and apparatus therefor, and the products resulting therefrom, of which the following is a specification.

This invention relates to an electrical treatment in the process of compounding of solids with gases, including solids with other solids and gases or either thereof and without liquid solutions, and to the apparatus therefor and the products thereof; and is illustrated herein by or in the manufacture of fertilizers of sundry basic components with nitrogen from air: and has for its objects: the electrification prior to the compounding, of the several components by means of friction and heat and current electricity; and the attaining of the compounding by electric forces or stress including electric adsorption and electric reaction forces in addition to ordinary adsorption and absorption and chemical reaction and the like: and to save time in and cheapen the present process, and to attain a product of increased density homogeneity durability and stability with diminished hygroscopicity. Other objects are set forth in the specification and claims.

In part, this invention embodies improvements upon parts of my Letters Patent No. 1,333,700 and 1,333,701 of March 16, 1920; and 1,334,590 of March 23rd, 1920; and 1,338,352 and 1,338,353 of April 27th, 1920.

As a process, generally stated, my invention consists, in the compounding of a solid and a gas component, in suitably drying and pulverizing the solids and in ionizing the gases by well known methods, and thereby and thereupon separately electrifying or conferring an electric or electrostatic charge or frictional charge or additional charge upon each component, as by thermal emission of electrons therefrom, and the grounding of such emissions: the components being charged of opposite signs and of higher potential in the positive than in the negative; and thereupon bringing and forcing the powders into suspension in and while moving with the gases under suitable pressure and temperature and velocity; and then withdrawing or separating the resulting compounds in fused or powder form or both from the waste and uncombined gases, all under insulated conditions, and under air-free conditions.

And similarly proceeding in the compounding of a solid with a different solid and with gases: that is to say, my invention consists advantageously in separately pulverizing each of the solids, and in ionizing the gases; and then separately electrifying each component, the different powders being electrified with opposite signs, with the highest potential in the positive, all while separately forced into suspension in a portion of said moving gases, advantageously previously electrified with sign opposite to the particular solid suspended therein and with different potentials; and thereafter blending the different powder suspensions, oppositely electrified, together with the gases and a secondary supply of gases; and then withdrawing the resulting compound from the uncombined or waste gases; all under insulated conditions; and with suitable pressure and temperatures and due motion.

And, in some cases, where a catalyzer has been heretofore used to accelerate reactions between like components, I may likewise use such but advantageously in dry powdered form and suspended in the gases simultaneously with the solids to be compounded. And from the crude mixed product thus attained, I separate and remove the catalyzer substantially as at present, or otherwise.

My process stated in an alternative form includes and is specifically illustrated herein, in part, by a process for fixation of nitrogen from air or producer gas and the like by compounding same, with a suitable basic solid in powder form by the method above generally stated.

Additional novel amplifications or alternatives of steps of the process are set forth in the remainder of the specification and claims.

As a product my invention in general, consists of a compound product illustrated by a compound fertilizer, with fixed nitrogen gases, and the like, compounded by electric and heat forces of a basic solid component or components in pulverized form illustrated by a calcium oxid or mono calcic phosphate or calcium carbid or cyanid or other fertilizer basic solid, and a gas, illustrated by nitrogen gases, each separately electrified, of opposite signs, prior to the compounding; and thereby attaining increased density in the compounded molecule which increased density results in increased stability and duration and decreased hygroscopicity; and further attaining increased homogeneity and increased amount or per cent. of nitrogen fixed through the compounding of the solid in powdered form while suspended in and moving in the gases under insulated conditions.

As a product my invention comprises a solid compound, advantageously in pulverized form for fertilizer or other use, comprising solid components electrically combined and compounded with gases, the constituents of the compound comprising the combinations and molecules from or of chemical reactions, and of adsorptions, and of molecular associations of said molecules and the like, each and all electrically activated and electrically compressed whereby increased per cent. of nitrogen is fixed and whereby increased density, stability, durability, homogeneity and decreased hydroscopicity are attained in the molecules and particles of the product.

By the term "of increased homogeneity, density, stability, durability, and of decreased hygroscopicity," and increased per cent. of nitrogen fixed and the like, I mean increased or decreased as compared with a compound product as now made of and from the same components or compounds, but without the prior electrification of the components as described, *i. e.*, before the bringing the components together as in present processes; and including those present processes, as in sundry electric furnaces, where an electric heat is applied to a mixture of the components; the broad distinction being that in my improvement, I electrify one or both or all components separately and oppositely and with one sign only before the compounding, and in addition as described with the solids in powder form suspended in the gases; and all under insulated conditions.

This invention practically applies and adapts with improvements, the following principles of physics; towit:

(1) The electrical principle that when particles under insulated conditions are brought into contact with the extension of one pole of a sufficiently high voltage source of constant or direct current electricity, the said particles leave the said contact electrified with a charge like that of the contact pole, and with varying degree of rapidity depending upon their electrostatic or electric capacity and resistivity or conductance influenced by temperature and in some cases by pressure and the velocity of molecular impact.

In my improvement, I adapt this principle to A. C. advantageously of low frequency about 16 cycles by providing means of grounding of one alternation, of each cycle, and means of contacting with the other or non grounded alternation of each cycle, under insulated conditions.

(2) The electrical principle that there is an emission of electrons from hot bodies and metal surfaces and the like, either positive or negative or both, depending upon the temperature, the nature and form of the body and influenced by an electric force; and the hot body being left with charge opposite to the emission; and similarly.

(3) That a static charge is attainable upon a particle by due friction, with the simultaneous emission of an opposite electron.

I advantageously avail myself herein of these principles and property of hot bodies and of friction in combination with the preceding principle, and the grounding of the thermal or emitted electrons from a component, it being more economical in general to develop electrical charges direct from heat and from friction, than from electrical current; and also because high temperature is often advantageous to effect chemical reaction or the like, and is preferred by me unless high temperature is detrimental otherwise.

The preceding and following principles are elucidated by and in the electron theory efficiently described, by well known scientists. In accord therewith and authoritative writers since 1913, I apply the word electron to both + and — electrons, and using the term positive electron and negative electron herein.

I also take cognizance of, and adapt herein sundry additional electrical principles involved in the said electron theory to wit:

(4) The atom consists of a heavy positively charged nucleus or matter with free positive electron or electrons, in number approximating half its atomic weight about which are grouped enough negative electrons to render the whole neutral.

(5) An electrical charge wherever found, whether on an insulator or semi-conductor or conductor, from any and every source, whether in electrolytes in solution, or gases or metals, or elsewhere, consists of an exact number of specks of electricity or electrons, positive or negative, which in static phenom-

ena or state, are scattered over the surface at rest with reference to each other; and in current, are drifting along the conductor.

(6) In metals the mobility of negative electrons is about 100 to 200 times that of positive electrons.

In electrolytes, in solution, the mobility of negative electrons is about 10 times that of positive electrons.

(7) Positive electrical charge or positive electrons, may be regarded as an actual entity which is always associated with matter, whose mass is not less than that of the H atom;

Negative electrical charge or negative electron is an actual entity alike for all kinds of matter and which may exist independently of matter and as though of a mass of about $\frac{1}{1845}$ that of the H atom.

(8) A positive charge on matter may be due either to the addition of or adsorption or absorption of positive electrons thereto, or thereon; or to the emission or withdrawal therefrom of a definite quantity of negative electricity or negative electrons; or both.

A negative charge on matter may be due either to the addition of or absorption or adsorption of negative electrons thereto, or to the emission or withdrawal therefrom of positive electrons; or both.

My improvements in compounding embody or add the electrical adsorption force, *i. e.* increased adsorptions through the additional superimposed electric or electrostatic charges of adsorbed electrons, advantageously negative from an exterior source of supply; or conversely by emissions of electrons advantageously negative from the component to an exterior contact material, and due grounding through low potential current contact.

As an apparatus, my invention generally stated, comprises, means of pulverizing the solids separately; with means of ionizing the gases, separately; with means of transporting and blowing the powders with jets of streams of gases into suitable retorts or electrifier conduits and compounding vessels and the like; with means of attaining the electrification of the powders separately by the application of friction in the pulverizers or in said retorts and the like, or both; with means of heat also applied thereto; with means of applying unipolar current electricity to the electrifier conduits and the like, and grounding by unipolar contact from each component and conduit separately and through the conduit, either both thermal and frictional emissions of positive electrons only or negative electrons only, thereby leaving, the atoms, molecules or particles electrified respectively negative only or positive only; and with means of unipolar contact to simultaneously or thereafter further electrifying or surcharging the components separately with additional like electrifications, *i. e.*, additional negative electrons only, or additional positive electrons only; with means thereafter of compounding the oppositely electrified powders and gases in suitable vessels, the final compounding vessel being advantageously dielectric; with means of heating the compounding vessel; with means thereafter of withdrawing any resulting compounds from the vessels both fused and in powder form, and separately withdrawing the non-used or uncombined or product gases; with means of controlling and regulating throughout the temperature, pressure, velocity, or degree of motion and the electric supply; and all under insulated conditions, with dielectric supports for all the apparatus.

As a part of the apparatus of my invention, and which I call the electrifier apparatus and which alone is also applicable to sundry present or existing apparatus for similar compoundings, my invention generally stated comprises a constant current supply circuit of electricity advantageously direct current, of suitable voltage and amperage, with means of earthing one pole thereof, and simultaneously electrically connecting the other pole thereof, to a suitable conduit or plate or the like, of conductor or resistor material; with means of forcing the materials in powdered form or gases or both, into, through and out of the conduit; and with an extension of the non-grounded terminal wire, advantageously in the form of a flat ribbon wire, which I call a trailer wire, through the length of the interior of the conduit; with a rheostat, ammeter, voltmeter, pole changer and circuit breaking switch in the said circuit; with means of increasing the difference of potential in the said circuit advantageously by means of the rheostat at and near the conduit; with insulator supports for all connecting apparatus; with dielectric joints in connecting pipes.

And where A. C. is used as hereinafter described, in lieu of the D. C. in the above combination, then, for grounding positive or negative electrons only, I advantageously use the interrupters or interrupter - selectors, and the operating mechanism therefor to ground the positive or negative alternations only as described in my Patent No. 1,334,590, and more especially as illustrated in Figures 7 and 8 and 9 and 10 of said Patent No. 1,334,590; and I use the non-grounded alternation for electrifying by contact substantially as with above D. C. combination.

Additional novel amplifications or alternatives of the apparatus, process and product, are set forth in the remainder of the specification and claims.

By the term electric supply circuit, I mean a metallic circuit of which the earth forms no part excepting as herein stated. This constitutes what I call the electrifier supply or circuit.

The D. C. supply may be a storage battery or a D. C. dynamo or a battery of numerous cells or a D. C. motor generator set, in connection with a standard lighting and power electric system or source of supply; or the equivalent.

Where the available supply is only alternating current, I advantageously convert such to D. C., by well known means such as a rotary converter or motor generator set or rectifier, or the like and with a previous step-up transformer, to first attain a high voltage with a continuous and steady potential; or a pulsating unidirectional current of great regularity.

I may also use an A. C., as herein described, advantageously reducing its frequency to 16 cycles, and increasing its voltage to high voltage, as hereinafter described.

I may also use the current from a static, frictional or influence machine or the like by grounding either its negative or positive pole, the other being connected with the electrifier conduit and the like.

Where a source of heat sufficiently high to attain emissions of electrons is employed as herein described, then I may use low voltage advantageously five to fifty in the electrifier circuit for mere grounding of the thermal electrons; and likewise from frictional electricity; otherwise for surcharging or further electrifying, without heat or friction I advantageously use high voltage; influenced also by the time of contact, the area of the contact surface and its amperage, and velocity of the moving material.

By suitable voltage I mean and include the ordinary commercial light and power electric supply systems of 110 to 220 V.

By resistance, or rheostat, I mean any device heretofore commonly known as a resistance, used for operation, protection or control of a circuit.

In connection with the use of resistance R Figs. 1 and 2 in the supply circuit, to attain drop of potential at the electrifier contact surface, for surcharging or electrification purposes, the amount of current flowing in the circuit is not diminished thereby; the volts lost equal the number of amperes multiplied by the number of ohms of the resistance; therefore I advantageously use in the circuit a voltage as above stated or in excess of the latter multiple, with its R increased by the number of ohms resistance in the remainder of the circuit.

I advantageously regulate the amperage, advantageously continuously supplied or renewed, by the area of the electrifier surface of contact, advantageously providing about one to ten amperes or more per square foot, per second of time of contact, to attain in the moving atom of material, an electrostatic charge of one millionth of an ampere or its equivalent number of electrons or E. S. unit or coulombs, or multiple thereof, depending upon the velocity or time of contact; and influenced also by concentration pressure and temperature; and the amount of material to be electrified.

I advantageously use a contact pressure of about two pounds per square inch; and a velocity for the solids advantageously in the conduits of about one inch per minute, or less,—the shorter the conduit, the longer time or less velocity.

I advantageously use a higher voltage or up to double voltage for positive electrification as for negative; and I advantageously so do by increasing the resistance through or of a rheostat in the circuit advantageously in the non-grounded terminal. Or I increase the voltage at the source. Thereby I increase the potential of the positive component as compared to the negative component; and such increase is advantageously in excess of the dissociating voltage of the compound or product plus the resistivity of the envelop of gases used; and with the effect that when such components meet or contact in the compounding chamber, and sometimes in the conduits and under insulated conditions, a compounding of the oppositely charged components takes place, electrically activated by having the potential of the one component higher than the other, and which may be described as electrical catalytic action; such compounding may be a chemical reaction where the components have a chemical affinity for each other; or it may be an adsorption; or an absorption; or the like; and in some cases accompanied by molecular association; and which may be determined by an empirical test and analysis.

If from any cause, such compoundings do not amply and quickly result, then it will be advantageous to increase the voltages; or the temperatures; or to conduct the compounding in an A. C., field in the compounding vessel, under insulated conditions as described in my aforesaid patents.

By the term insulated conditions, I mean and include, the supporting of the apparatus on dielectric supports, advantageously water cooled; and advantageously the inclosing of the exterior of the apparatus, electrifier conduits, connecting piping, etc., with an envelop of dielectric covering or insulating paints and cements and the like; and the use of dielectric joints in connecting piping; and such insulation being sufficient, because the electric current proper sticks to and seeks the easiest route towit: the electrifier supply circuit described, though a convection current of the one sign, or what may be called a unipolar convection current by contact of moving particles, of the materials being treated, may arise from kinetic energy, or force impressed by physical agitation or blowers and the like, and which force often results in a particle preferably taking up or adsorbing another particle of like sign, which may result in molecular association and the like, or may result merely in increasing the number of like electrons on a particle, increasing its static charge.

As an insulator material, where high temperature is employed, I advantageously use boron nitrid, which does not lose its insulating property, at the greatest heat used herein.

By the term compound, or compound product, or compounding, I include the products of chemical reactions, of molecular associations, of adsorptions, of absorptions, and the like, of the components, and mixtures or combinations of such products including alloy-like mixtures and blends and solid solutions of molten fused particles, of and with any such. And the vessel or chamber, or any conduit performing the like function in part, I include in the term compounding vessel.

By the term gases herein, I include vapors and sprays.

I do not restrict the general process to the particular electrical means, current or apparatus as described for attaining electrical charges on any material but may use other electrical means.

I attain this invention by the mechanism illustrated in diagram, in the accompanying drawings, and showing the application thereof to present processes and apparatus; and in which similar letters and numerals refer to similar parts throughout the several views; to wit:

Fig. 1 is a diagram of the electrifier apparatus from D. C. source, with a motor generator and frequency converter and step-up transformer and rotary converter in the circuit to attain D. C. high voltage, as applied to an electrifier conduit.

Fig. 2 is a diagram of the electrifier apparatus from A. C., source with a shunt therefrom having an interrupter therein for grounding only positive or negative electrons.

Fig. 3 is a diagram of vertical longitudinal section of the apparatus in applying the process to compounding solids, such as CaO or CaC and the like, with ionized gases such as N, where the former emit negative electrons by heat; and in combination with electrifier Figs. 1 or 2.

Fig. 4, ditto with alternative means where the solids such as the phosphates emit positive electrons by heat and by friction; and in combination with applying the electrifiers Figs. 1 or 2.

Fig. 5, ditto with alternative means where one of the solids emits negative electrons and another solid to be compounded therewith (in addition to gases) emits positive electrons by heat and by friction; in combination with applying electrifiers Figs. 1 or 2.

Fig. 6 is a vertical longitudinal section in diagram, of a suitable apparatus for separating and collecting powders and powder products of different sizes, applied to and in connection with the exit end of any compounding vessel or furnace and the like.

Fig. 7 is, in diagram, a vertical longitudinal section of a type of powder and gas jet injector nozzle, with electrifier Fig. 1 applied to the nozzle, with centrifugal in the mouth of the twyer or nozzle.

Fig. 8 is a diagram of a vertical section of walls of a heating furnace supporting one joint of electrifier conduit of Figs. 3 or 4 or 5.

Fig. 9 is a diagram of a longitudinal section of a shorter joint connecting two of the joints of Fig. 8 and with a gas-blower nozzle projecting therein.

Fig. 1 is a diagram of the electrifier apparatus comprising a direct current metallic circuit of which the earth forms no part, as from a direct current generator D. C. G. with leads $-W'$ and $+W'$, or dynamo or storage battery and the like; and with a circuit breaking switch S' to cut out the supply when not operating; in combination with a motor generator set M. G. and the like to convert said primary D. C., into a primary A. C., of low frequency, advantageously of 16 cycles per second, advantageously of single phase and symmetrical; or if such is not of 16 cycle, then I advantageously provide a frequency converter F C with a double pole switch S_3 which when manually closed, throws F C into the circuit of the primary converter A. C., as shown, preceding the transformer; and in combination with said primary A. C., I provide a step-up adjustable transformer 88 to transform the low voltage supply such as the A. C. converted from the D. C. G. or a storage battery or other continuous current supply which may be that of the usual city lighting or power supply of about 110 V. or 220 V. I transform such to high voltage advantageously about or over 220 V. for negative electrification, and when the positive pole is to be grounded as hereafter explained; or about or over 440 V. for positive electrification; and thereafter, I provide in further combination with said transformed or secondary high voltage A. C., a second rotary converter R C or the like to transform such A. C., to a secondary direct current supply current $-w$, $+w$ of about such high voltage, and which is the D. C., in fact applied for the electrification and grounding herein described: and for such latter purpose, I further provide in combination therewith, the pole-changer switch P. C., manually adjustable, to ground the positive or negative pole or lead, the other opposite pole or lead being simultaneously connected with a rheostat R; and with a manually tripped circuit breaking switch S and a clamp C E for clamping and electrically connecting the lead w to a suitable electrifier conduit P (with insulator support I,) through which the powders or gases and the like are duly forced for electrification thereof by what I call unipolar contact with P, and as hereinafter described; and the said lead wire w is further provided with an extension thereof advantageously as a ribbon wire or the like baffle wires of resistor material, H projecting into the conduit P throughout its length advantageously heated by the current. In said secondary D. C., circuit, I advantageously provide an ammeter A and voltmeter V and a galvanometer, in the grounded terminal line $-w$ as shown, or in the non-grounded terminal line $+w$.

The P. C. as shown is adjusted to contact with b^3 and b^2 the — and + leads respectively, thereby to ground the negative, and for carrying the positive to P when S is closed; and when P. C., is changed to contact with buttons b^2 and b^1, the reverse connections are made, namely the positive is grounded and the negative carried to P.

For hot conduits, under 300° C., I advantageously use a conductor metal for making the electrifier conduits to facilitate the grounding of the thermal electrons emitted from the powders; and for that thereby a most extensive surface for contact is available; and likewise where the conduit or a second electrifier conduit like P^1 Fig. 5 or B^1 of Fig. 4 is intended also to further surcharge the powders or gases respectively. For temperatures over 300° C. I may advantageously use a vitreous material or the like or a dielectric, which will not fuse or leak at the said temperature.

And when from any cause the electrifier conduit is made of a dielectric material such as stoneware, which I advantageously use where highly heated and where emissions of electrons are not desired from the conduit to the material passing therethrough, then the ribbon or the like metal extension wires H of Figs. 1 and 2 or a number of such wires, in the circuit w w' as shown act electrically like the metal conduit as described. And such extension is advantageously of thin flat wires of resistor material electrically heated by a shunt from the current. I include such "extension" in the term "conduit plate and the like" herein and in the claims.

I advantageously connect to and as part of H at the end within the conduit, a coarse woven wire screen or baffle screen as of nichrome wire, H Fig. 8 of about 10 mesh which will permit the ready blowing therethrough of the powders. And in some cases, such H may be made of a wire which acts catalytically.

In my Patent No. 1,334,590 Fig. 10 and part of Fig. 9 is an improved apparatus advantageously in the ground line for forcing to earth with additional force than a mere ground line only, the freed thermal electrons and the like; and likewise advantageously used herein.

Further amplifications of D. C., electrifier apparatus are described in the above patent.

Fig. 2 is a diagram of the A. C., electrifier apparatus proper where A. C., is used; A. C. G. is the alternating current generator or source of A. C. supply and which is advantageously of low frequency 16 to 25 cycles; for higher cycles, a frequency converter, not shown, is advantageously used to reduce to 16 cycles. w^1, w^2 are the metal wires of the circuit; S' is a manually tripped double pole circuit breaker switch; 88 is an adjustable transformer to raise the usual city supply voltage of 110 to 220 V. or the like, to any desired high voltage, advantageously over 220 V. for negative and over 440 for positive; or less where external heat is used as herein described. Where the object and function is merely to constitute the earthing means of electrons emitted by heat from the powders herein described, and the like, no transformer is needed and such can be cut out entirely, and the ordinary voltage of the lighting or power supply of 110 V. is ample; or even as low as five to 60 V. is ample.

11 represents impedance, and 17 capacity, an adjustable condenser, R a rheostat, A an ammeter, and V' a voltmeter in the A. C. circuit; C E is a clamp or the like electrical connection attained as by brazing or soldering to the circuit wires w and w', electrically connecting the circuit to P, the electrifier conduit or retort and the like when of metal; and when the conduit is a dielectric then w—w' are extended into the interior of P' in the form of a flat ribbon or double wire H or the like woven wire baffle advantageously made of a resistor like nickelin wire, which will not obstruct materially the flow of materials through the conduit; and which can be heated red-hot or higher by the current. When thus heated H performs the function of the electrifier contact or of the metal electrifier conduit herein described. I include such extension H in the term "conduit plate and the like" in the claims. This trailer extension is also advantageous when the conduit is of metal, though not so essential. w^3 and w^4 are the metal wires of a shunt circuit from the main circuit w w'; and in which w^3 and w^4 shunt circuit is the interrupter X details not shown, same being described in and illustrated in Figs. 7—8—9—10 of my Patent

No. 1,334,590; or any equivalent device which may be called a selector or interrupter selector manually permanently adjustable to select or pass therethrough to ground, through wire w^5, only positive or only negative electrons and alternations in synchronism with the like + or − alternations of cycles of the A. C., in the said principal, or frequency circuit.

In the A. C., electrifier Fig. 2, I advantageously use two step-up transformers to attain high voltage towit: 88 and 88′, the former duly wired to attain the higher voltage, advantageously double, for positive electrification than the latter 88′—for negative electrification; and with an additional double switch S^2 in the leads w^6 and w^7 from 88′—so that thereby w^6 and w^7 may be entirely disconnected from the circuit; and likewise with an additional double switch S^3 in the leads from transformer 88+. The switch-board of S′ has six contact points or buttons 1—2—3—4—5—6, of the wires; and two buttons b^7 and b^8 of the double switch S^1; and two buttons, b^9 and b^{10} of the double switch S^2; and two buttons b^{13} and b^{14} of switch S^3.

I operate same as follows: The clamp C E is duly fixed to the electrifier conduit P; when the process of passing the powders and gases through P is not in operation, switches S^1 and S^2 and S^3 are thrown open, as shown in Fig. 2; and when the powders and gases are being passed through P, there are three possible adjustments of the switches to meet the requirements of the process; first: for grounding free electrons only, S^1 is adjusted so that its buttons b^7 and b^8 are in contact with 1 and 2 respectively, and in addition the interrupter X is adjusted to ground negative only or positive only depending upon whether the thermal free electrons in P be negative or positive. The switches S^2 and S^3 are left open excepting when additional resistance is wanted in the circuit whereupon one or both are closed and whereupon the step-up coil only of the transformer is in the circuit as resistance—the transformer itself not operating.

Second: For electrifying or surcharging the powders in P positive, the switch S^1 is adjusted so that its buttons b^7 and b^8 are in contact with 3 and 4, and switch S^3 is closed, and switch S^2 is opened and whereupon the transformer 88+ is in the main circuit and the high potential advantageously over 440 volts is attained, for attaining the higher potential to be given to the positive powders by contact in P (the negative being grounded through the manual adjustment of X); such increased voltage is also advantageous as a ground forcer to drive the selected desired electron to earth.

Third: For electrifying, or surcharging negative, the gases as in B Fig. 3, or the powders as in P^3 Fig. 5, the switch S^1 is adjusted so that its buttons b^7 and b^8 contact only with buttons 5 and 6 respectively,—and switch S^2 is closed so that its buttons b^9 and b^{10} contact with b^{11} and b^{12}; and switch S^3 is opened; and interrupter X is adjusted to ground positive only; and thereby the transformer 88′ only is in circuit to give a high potential but only advantageously about 220 volts or over or about half the potential given to the positive.

It will be understood that in lieu of using two step-up transformers 88+ and 88′— as explained, I also use only the one adjustable step-up transformer 88, manually adjusting it materially higher advantageously double for positive than for negative; and omitting entirely the 88′ or its operation excepting when the use of its fine wire secondary coil is desired as assistance and which aids in attaining difference of potential; and for which purpose S^2 is closed while S^1 is adjusted so that its buttons b^7 and b^8 are in contact with buttons 3 and 4 of adjustable transformer 88+.

Moreover, the advantage of two separate transformers may avoid confusion by a careless operator by marking the one (88) positive and the other (88′) negative.

For brevity, I hereafter call or designate the whole apparatus of Fig. 1 as E^1 or D. C., E^1, and precede E with + or − sign when applied with the positive or negative pole grounded respectively. And likewise, I hereafter call or designate the whole apparatus of Fig. 2 as E^2 or A. C. E^2 and precede E with + or − sign when applied with the adjustment to ground only positive or only negative emissions of positive or negative electrons.

And when the principal use of such apparatus is as herein applied for grounding such emissions from the moving powders and the like, and which emissions are due to heat, generally not from electric source, then I call the apparatus of Figs. 1 or 2 with designation G E^1 or G E^2 "emission grounder" or emission grounder apparatus as distinguished from the name "electrifier" or electrifier apparatus, when it is used principally to electrify the moving powders and the like by contact and when I use designation E^1 or E^2, or to emit electrons by contact, which may be called unipolar contact, to the moving powders from the fixed electrifier conduit P and the like. In the latter case, a much higher voltage is used and with the D. C. E^1 the + pole is grounded to electrify the moving powders, etc., negative, *i. e.*, negative unipolar contact, to cause the emission from fixed P of negative electrons where it is desired to have such taken up by contact by the moving powder; whereas on the contrary, in the former case, *i. e.*, to act merely as "emission grounder" of negative electrons emitted from the hot moving powders as with CaO, the negative pole of the D. C., E^1 is grounded; and conversely when the thermal emissions are positive as with phosphates. And likewise when A. C., E^2 is used or applied as an emission grounder of emitted negative electrons from the moving powders, then the interrupter selector is manually adjusted to ground only the negative alternation of each cycle of the A. C., as described.

The contacting and electrifying and surcharging of materials in the conduit and the like, and the earthing therefrom of thermal electrons or the like, including ionized gas, electrons by and through the electrifier apparatus as described or the equivalent, I call unipolar contacting.

I advantageously electrify solid components by friction in the pulverizing or by heating same in powder form by contact with hot surfaces at sufficiently high temperature to cause emissions of electrons therefrom, or by both; and I simultaneously or instantly thereupon and thereafter ground such emissions by the unipolar contacting apparatus described; and thereby the solids are left charged with the opposite sign.

And conversely I also electrify the powders by the addition thereto of electrons emitted by heat from the contacting surfaces, advantageously of good conductor metal.

In Fig. 3 is shown the application of said A. C. electrifier apparatus of Fig. 2, to the U shaped conduit retort P whereof more detail is shown in Fig. 8; heated exteriorly by any hot blast system Y to high temperature advantageously 240° to 290° C. for iron conduit and preferably 700 to 800° C. for conduits of any material not fusing thereat; the pulverized solids are blown with great force after and upon falling from a supply bin D, whence the powders fall by gravity upon a nozzle N of a twyer T projecting into P, through which nozzle is blown a jet from gas-conduit B^1 of compressed ionized gases, blown by a compression centrifugal blower Q or the like, from a suitable gasometer G not shown in detail, or from source of gas supply not shown, into and through pipe B^5 and thence into a U-shaped retort or tube Q C heated by gas blast Y,—being filled with loose charcoal or copper granules to absorb oxygen from the gases or air being forced therethrough from Q; and thence through a pipe B^4 and ionizer U V—an ultra-violet ray ionizer, details not being shown, and thence through the twyer T and nozzle N into P, simultaneously there sucking and projecting the powders from D into the gases and which further carry and project the powders against the hot inner surfaces of the conduit retort P, supported on insulators I, (see Fig. 8), and heated exteriorly by hot blasts or coal or gas or petroleum or gasolene flames Y and the like. A branch pipe B^2 draws additional ionized gas from B and advantageously injects same through jet nozzle N^2 into the upper or second bend of the U retort, carrying the powders into the compounding vessel or furnace V; and into which V additional streams of secondary and principal supply of similar gas is forced by several nozzles N^5 supplied from gas conduit B by branch pipe B^3 preceding U V, and leading to another ionizer U′ V′ thence to a U shaped gas conduit B with electrifier apparatus E^2 applied thereto to electrify negatively and thence injecting the gas only, into V through several nozzles N^5 from branches of pipe B not shown; with the addition of advantageously injecting into B_3 and preceding the ionizer U′ V′ a spray of a basic salt solution, as hereinafter described, to further assist in the ionization and electrification of the gas; such spray is best introduced separately from the conduits for the electrification of the powders. Insulator supports I, are advantageously hollow with means of cooling, not shown, like water-cooled electrodes.

The vessel V, is advantageously a closed vessel furnace, further heated exteriorly by well known means Y, to attain in the vessel the desired compounding, or reacting temperature; such temperature may be attained in the electrifier conduit if made of any metal or refractory material which will not be injured by the high temperature,—and in which case such conduit may also constitute the compounding vessel.

The compounding chamber of vessel V, is advantageously quite extensive, advantageously over four times the volume of the compressed gases and like a long reverberatory furnace; and with the object of diminishing therein the velocity of the moving gases with suspended powders by expansion into the large space and to thereby sometimes facilitate the contact of the CaO with the —N gases.

For the electrifier conduits and compounding chambers, I avoid pure iron as a material for constructing same on account of the catalytic effect of such in decomposing the cyanogen compound at very high temperature; but steel or copper or other metals named herein may be used.

The vessel V is advantageously of the types either horizontal or vertical or inclined retort or furnace or kiln lined with refractory insulation material and either fixed or rotatory; and practically air-tight, dust-proof, water-proof, with means of heating such to about 700 to 1400° C. prior to starting the compounding; and with means of cutting out or stopping exterior means of heating where the heat of the reaction is ample to continue the process. It is advantageous to regulate and control the heat of the conduit to be less than the fusing temperature of the powders, *i. e.*, calcium 805° C., lime 2565° C. or the temperature of the back action, or decomposition of the product, *i. e.*, 1400° C. for cyanamid CaN_2C beyond which it disintegrates with freeing of the N; and the like.

In the compounding vessel V, and also where the conduits are lined with or made of a dielectric material, the lining is advantageously of refractory material to withstand the high temperatures, such as Dinas brick or fused quartz, or a fused mixture of zirconia and quartz which remains gas tight and non-porous at the high temperature employed. As a dielectric, boron nitrid has been found to continue as an insulator at the highest temperature employed.

The electrifier conduits P and the like, are advantageously heated from exterior source of heat Y, by duly placing same in a furnace, not shown, except at 50 Fig. 8, like an enlarged muffle furnace, analogous to those now used for heating retorts to a high temperature; and with like source of heat, advantageously a blast lamp and the like. Or, where electricity is very low priced, as when generated by a near-by large water-power same may be heated electrically, by well known means and which may simultaneously constitute my electrifier currents (or vice versa) of Figs. 1 or 2.

As a general rule, when the electrifier conduit of conductor or resistor material and the like is heated to materially over 400° C., both positive and negative electrons are emitted; and one kind of electron is grounded, as explained by the suitable adjustment of the E^1 or E^2 employed, and the other kind of electron largely further electrifies or surcharges by contact, the passing powders or gases, either neutral or oppositely charged, or in some cases, when of the same sign, due in part to its velocity or momentum overcoming the repulsion of like charges.

In and for the treatment of the solid components I may either first dry and then pulverize and store the powders in suitable bins D^2 feeding into bin D by gravity and endless screw propeller *p s* a well known method with details not shown; and thence feed by gravity as wanted into the electrifier conduit P per the nozzle N of twyer T blowing the powders and gases into same as shown in Fig. 3.

Or (2) I may dry and then pulverize the solids only as wanted; and by a type of pulverizer as shown at 16 Fig. 4, and 18 Fig. 5, with a blower Q injecting the powders mixed with gases, direct into the electrifier conduit P through suitable nozzles N of suitable twyers not shown. In such there is a commingling or mixing of the gases with pressure with the powders which together are blown and forced through the connecting tubes and electrifier conduits into the compounding vessel V.

In most cases I use advantageously a secondary and the principal supply of ionized and electrified gases under pressure, blown direct into the compounding vessel V, using a part of the gases only at the pulverizer and conduit for injecting the powders therethrough.

The object of grounding the negative electrons or most thereof, emitted from the hot CaO or the like by heat or friction, as hereafter stated, is to attain the effect, so that the remaining positive molecules or powdered particles which are then positive, may the more readily take up or compound with the ionized negative nitrogen gases or even neutral nitrogen gases when subsequently encountered or in contact therewith in the conduit P or an ensuing conduit, and more especially with the secondary and principal negative gas supply in the compounding vessel V.

The provision or means indicated of manually changing the pole or cycle, *i. e.*, the plus or minus alternation of the A. C. to be grounded (and which proceeds automatically after the one manual adjustment), is essential for the reason that different kinds of powders to be similarly compounded with gases by this process, emit different electrons, some positive and some negative at high temperatures; thus the inorganic oxids emit negative electrons, whereas the inorganic chlorids and also the phosphates emit positive electrons; and the nitrates emit positive until converted into oxids after which only negative electrons are emitted; and upon such emission the powder is left oppositely charged. It will be understood there are minor exceptions to said general rule as for instance lead peroxid; all such can be readily determined empirically. Therefore in the process with phosphates and the like, which emit positive electrons by adequate heat or friction, the above adjustments will be manually made to earth the positive pole of the D. C. E^1; and the positive alternations of the cycles of the A. C., E^2, where the latter is duly applied as described.

When the solids are pulverized as at present and stored in bins as in D^2, Fig. 3, before feeding therefrom as described, or from D Fig. 3,—I advantageously exhaust air and moisture therefrom by well known means not shown as by closing same and connecting with a vacuum pump or vacuum chamber; and then cut out the latter before opening a suitable valve *v*, whereupon the powder feeds into conduit P by gravity and suction of nozzle N and its incoming gas.

It has been demonstrated that there is a most marked emission of negative electrons from CaO, and other basic oxids on a cathode electrode when heated between 700 to 800° C., though commencing to emit such at 240° C.

It is immaterial how such heat is attained whether electrically or by the application of an external hot blast.

In my process, I advantageously attain such heat by external hot blast for the reason of its economy, applied in a suitable furnace, to the exterior of the conduit or retort through which the powder is blown; or I may so do by heating the metal conduit or retort acting as a resistance in series in the electric circuit described when carrying a large current; or I may use both; or I advantageously use the former method together with the similar application of a small current to the retort, for the purpose of grounding the emitted electron (the negative in the case of CaO as shown at $-E^2$ of Fig. 3) and by bringing the powders violently into repeated contact with the heated conduit as described, the heat of the latter spreads to the powder and thus the CaO is in fact, when in contact, on the cathode for the time of the contact, and at such time emits negative electrons, the CaO being thereby left positively charged. Some of said negative electrons are grounded in nascent state forthwith when emitted by contact with the adjoining A. C. electrifier surface during the negative alternation, *i. e.*, when the surface becomes negative (which it does become 16 times per second when the frequency is 16 cycles) and reaching the earth therethrough and through the interrupter selector X, previously adjusted to pass therethrough negative electrons only.

Again some of said negative electrons are neutralized during the ensuing positive alternation of the cycle on the surface of contact of the same conduit; (or of an ensuing positive section of conduit where such is used as P^1 of Fig. 5). Again some of said emitted negative electrons may be taken up by the ionized gases surrounding and carrying the powder, even though such be negative, for the reason that the kinetic energy of the moving particle of gas more than counterbalances the repulsion of like charges. Again some of said emitted negative electrons recombine with some of the positive CaO powders, but such may again be emitted and grounded on subsequent contact of the powders with the surface further along in the conduit. Therefore it is advantageous to use very long conduits. It is impractical to state exactly what portion of the emitted electrons take any one of the courses above indicated, such being influenced by the accident of different contacts due to the kinetic energy from temperature and pressure and velocity of motion and to the form of and length of the conduit or retort.

The particles of CaO upon the emission therefrom of negative electrons become thereby positively charged and are carried by the transporting gas accordingly through the same conduit (and sometimes through a connecting conduit) and thence into the compounding vessel, V. Most of the gas to be compounded therewith is introduced separately and either oppositely charged after ionization, or neutral into the compounding vessel; only a minor portion thereof being used as may be necessary for the transportation of the powder from its source of supply to the same vessel; and this for the reason that the positive CaO combines with the neutral or negative nitrogen gases to form calcium nitrate and calcium nitrite and the like, and which fuse or melt at about 499° C.; and if a higher temperature be used for the conduit as for instance 800 to 1100° C. such will not fuse the CaO which will in fact have its surface cleaned to combine with N gases and the fused compound portion if any may be periodically withdrawn from the bottom valve O^1 (see Fig. 8) of the conduit P, to which it gravitates; or may be blown onward like a spray by a blast nozzle N^2 (see Fig. 8) at or near O^1 and with the powders into the compounding vessel, for withdrawal of the fused portion separately from the bottom through doorways O_2 of the compounding vessel V like from certain forms of reverberatory furnaces.

In cases where emissions from a component are to be grounded, I may advantageously construct the conduit of stoneware or other refractory material, with the electrifier apparatus applied thereto having the trailer ribbon wire H or E^1 or E^2, Figs. 1 or 2 projecting into the conduit P throughout its length, *i. e.*, I advantageously use such where reliance is placed entirely upon the external hot blast for heating; and the electrifier trailer is then used more especially to earth or neutralize the electrons from the CaO and the like powder. The conduit is advantageously placed obliquely, higher at one end than the other, and made of several **U** shaped sections with a hermetically sealed door not shown at the base of the **U** or a suitable valve and cock O_1 at the bottom angle to withdraw therefrom periodically the fused products into suitable receptacles to be cooled and then pulverized for use as fertilizer or other purpose.

Or in lieu of thus withdrawing at O_1, a gas blast nozzle may be hermetically introduced at O_1 or the like to further blow and spray the fused compound from the conduit into the compounding vessel V and thence withdrawn from suitable openings O_2 from gutters or puddles in the bottom of the vessel into which the fused portions flow and gather by gravity. The gas which acts as the carrier is freed from oxygen before it is employed as carrier of the powders as described and may be then used either in neutral state or non-ionized,—or advantageously in ionized state as described.

The heat employed does not ionize the gas; and in some cases, I use it accordingly non-ionized and in the manner described for transporting the powders into and through the electrifier conduit; and in such cases there may be little or no combination of the emitted thermal negative electrons therewith, in the conduit. But in other cases where I use the ionizer to ionize and negatively charge the gas, there may be earthing of some of its electrons in the conduit; and again there may be compounding of the N gases, in part, in the conduit with some of the powdered positive CaO.

It is advantageous to introduce separately most of the gases *i. e.* all the secondary supply of N gases, duly ionized and electrified negatively into the compounding vessel V as through several nozzles N^5 from electrifier conduit B and another ionizer U′ V′ and branch pipes from B not shown, to N^5; such negative gases meet the powders CaO electrified positively, and separately introduced into V and for due compounding therein.

The conduits are supported on insulator sleeves or rings I I, at the points of entrance into the vessel V.

I advantageously prolong the compounding vessel by an extension like a long brick-dust flue or smelting furnace dust flues beyond the furnace which flue of refractory brick lining may be several hundred feet long raised on piles with hoppers beneath and facilities to discharge from the hoppers into cars beneath.

As a silica or fire-clay brick rapidly wastes away, when in contact with a molten substance containing a large per cent. of lime,—the refractory linings used in the compounding vessels are advantageously made of magnesite brick.

The absorption, electrical adsorption and chemical reaction of the powders and gases begins in the injector nozzle and continues in the conduits and is completed principally in the compounding vessel. When the gases blown through the nozzle meet and inject the powders, the commingling of the gases and powder is followed by adsorption in and at the nozzle if the temperature is sufficiently high; and the reaction follows in the compounder when its temperature has attained the reaction temperature.

Before commencing the injection, the compounder is first heated to the reaction temperature by well known means; and such means are discontinued if the reaction is exothermic. And if the heat of the latter rises above the point where there is a reverse or dissociating action as for instance 1400° C. with cyanimid, then all external means of heating are cut off; and means of cooling must be provided such as injecting cold gases, etc., or utilizing cooling exterior tubes; and additional powder injections suspended until the chamber has cooled to the desired temperature.

The powdered products which may continue in powder form in the gases in the compounding vessel are separated and collected as described; or in other well known methods of separation ensuing upon cooling of and retarding velocity of the gas as by enlarged ensuing vessels and long flues, with change of direction and introducing a counter-blast toward end of flue of cold gases, and about center of length of flue of hot gases.

Fig. 6 is a diagram of a vertical longitudinal section of one form of apparatus for separating powders from gases, applied to end of compounding vessel V Fig. 3; and also advantageously used likewise with Figs. 4 and 5. In the collection of the resulting compounds in powder form, from the compounding vessel, I use any of the present well known apparatus for collecting and separating powders from gases and air, and advantageously use a type devised by Dr. J. F. Mackey of the University of Kansas for determining fineness of powders, as explained in Technological Paper No. 48 of 1915, page 20, of the U. S. Bureau of Standards; and applied by me as illustrated in Fig. 6 in combination with the compounding vessel V; and in which F is a pipe, with shut-off valve and cock, from the end side or top of vessel furnace V, for the exit therefrom of powders in suspension in and with compressed gases in V, and which are blown therefrom into flue F and sucked therefrom into separator chamber C_1 by a blower of gas from B^8 through nozzle N_7; and thence into separator chambers C_2 and C_3, being well known top and bottom conical shaped closed separator vessels, with connecting flue or pipe F_2 between C_2 and C_3 with exit flue F_3 from C_3 to chimney F_4 for waste gases; or with a pipe F_5 from F_4 with control valves F_9 to close exit to chimney, and valve F_{10} to open the way into F_5 which carries the gases back to any of the apparatus to be heated or for re-use at the gas supply source; and I advantageously provide between C_3 and chimney in F_3, a U shaped joint or trap F_6 whose bottom has a loose wad of fibers of glass or asbestos threads or the like to catch minute powders, and which joint has a hermetically sealed door M to give ready access to the U joint to remove and renew the wad and remove the few powders therefrom. A similar U shaped dust collector joint is shown in Fig. 4 between C_1 and C_3.

The cone of chamber C_2 is open at top, and lies within C_1 as illustrated, the distance between the two widening at the top, to about double the width at bottom. Most of the coarser powders drop out in C_1 and are withdrawn with others falling in from O_3 into suitable receptacles; any finer particles clinging to the walls fall therefrom by gently periodically tapping the outer wall. A powder withdrawal spout or the like with valve, O_3 as shown is at bottom of end of furnace, but such may be alternatively provided below C_1 as at O_6 from pipe F, such O_6 having a perforated or open wire catch-plate projecting into F. In F is a dielectric joint D J. From the open spaces above C_2 a large portion of finer powders drop out and into C_2 and are removed from exit O_4, the finest powders are carried over through F_2 into C_3 and are withdrawn therefrom at O_5. Any of the powders still in suspension are blown with the gases into F_3 and are stopped by the wad in U shaped joint F_6. Suitable valves and cocks are placed at outlets O_3, O_4 and O_5 to periodically withdraw the powders therefrom. The coarser powders or grits may be reground for use as fertilizers in some cases and in others are again added to the original powders used in the process. I advantageously use a similar system of separators and collectors as above described for such regrinding; and advantageously a battery of several such for separating the original pulverized solids as such come from the pulverizers, prior to storage in bins.

It will be understood that any vapors as of metals and compounds thereof and the like arising during the process or passing off with the uncombined gases through F and the like of Fig. 6, can be condensed and separated and utilized substantially as at present.

Fig. 7 is a diagram of a vertical longitudinal section of a pressure powder and gas injector of well known type, modified and with the nozzle N of gas conduit B advantageously of resistor material in series with a metallic electrical circuit which may be either E_1 or E_2 or other current suitable for heating the nozzle red-hot or over, where such is desired in combination with a powder inlet conduit pipe P whence the powder is sucked by the jet of compressed gas from pipe B and then projected either direct into an ensuing conduit not shown, or into compounding chamber not shown; or advantageously projected against the twyer frustum of a cone T having at and in or near its mouth, a screw or propeller like blade *bl*, perforated and electrically connected with GE_2 with either plus or minus grounded, depending upon whether + or — electrons are emitted by the hot powders. Such blade *bl* further mixes and causes close contact of the powders and gases on the electrified surfaces of the blade and its perforations while being blown therethrough. The twyer T advantageously rests on insulator supports I at entrance point to ensuing conduit or vessel. In some cases P is insulated from N and B; but not so where high heat would destroy the insulation and in which case, the electrification of the powder only is applied, that of the gas being neutral or neutralized. Secondary and principal supplies of gas may be blown by B_5 into twyer T from its side.

I advantageously use a centrifugal screw-like or propeller like blade in the mouth of the twyer T Fig. 7 to attain a centrifugal whirling movement and intimate mixture of the powders and gases.

And for injecting gases only or gases and spray, I advantageously use the well known centrifugal spray type of nozzle not shown; and in some cases also for powder and gas injections. And further, I advantageously make same of resistor material and electrically connect same with the positive pole of the electrifier apparatus with negative grounded, in order to thereby further charge positive the basic powder and the like or its blend with gases or the gases with sprays, or the gases alone, forcibly passing therethrough; and conversely I electrically connect the nozzle N for the carbon powders and the like or its blend with gases, with the negative pole of the electrifier apparatus having its positive grounded, and having about half the potential of the former;

It will be understood that by the term frictional electricity, herein, I include such arising from violent passage through such nozzles.

Where the nozzle is not used for electrification or as an electrifier by means of the E^1 or E^2, *i. e.*, of gas, but is used merely as an injector of compressed gas for inspiration or the like of the powders, the electrification of the conduit of the powders only, is considered and effected as described. The gas being considered as neutral and the electrification of the gas being allowed in the main and secondary supply of gas in conduits B prior to the separate injection thereof alone, into the compounding vessel V.

Fig. 8 is a diagram of vertical longitudinal single section of a joint of electrifier conduit P in Figs. 3 and 5, in tubular form, advantageously U shaped and of elliptical or catenary cross section, and made in lengths advantageously of about six feet to ten, advantageously shown as duly supported on insulator supports I, in and through the walls 50 of one form of a muffle heating furnace; the conduit P having an enlarged end 30 advantageously projecting outside the wall for connections from electrifier E_1 or E_2, also for inserting a preceding conduit or short joint like Fig. 9 or pipe connection, for powder injections and the like with the exit end 31 to fit into the enlarged entrance end of an ensuing similar section, or into end 32 of a shorter cylindrical joint P^9 Fig. 9, of the conduit, having a circular hole 34 with slanting edges in the top or side for introducing, with hermetically sealing, a blower nozzle N from gas conduit B, and wire H if desired of electrifier E^1 or E^2 Fig. 1 or 2, to project into P^9 and applied either to the nozzle N of B or to P. Such latter P^9 of Fig. 9 may be of same material and cross section as P of Fig. 8, or it may be of dielectric material where such is needed, as elsewhere described. In Fig. 8 the bottom of P is shown with an inclination advantageously over 15° so that any molten product will flow to and into an orifice at the bottom connected with an exit pipe O^1 with valve and cock to be opened periodically to withdraw the fused product, if any, advantageously under pressure of the passing gases. A gas blower nozzle N^2 is advantageously introduced into the bottom of P adjoining the exit into pipe O^1 or nearby for periodical use.

It will be understood that such electrifier conduits and the compounding vessel are quite long, the length to be determined empirically for different products; or such in lieu of the length as illustrated in part only, may consist of several smaller sections each section shaped as illustrated, and duly hermetically sealed into each other. And in the successive sections of the conduits P and vessel V, I advantageously use different increasing pneumatic pressure blowers Q_2 Fig. 5 or injectors of gases and the like, and increasing heat temperature and increase of A. C. voltage of E_2 in P_1 of Fig. 5 and the like to thereby and to therein attain different zones of the compoundings in the successive sections.

Fig. 9 is a diagram of a vertical longitudinal section of an advantageous form of a short joint between electrifier conduits or between such, and the compounding vessel—having a cross-section not shown, like that of the conduit; and with an enlarged mouth 32 into which fits and is sealed the end 31 of Fig. 8 of electrifier conduit and the like—its opposite end 33 to fit into an ensuing section, a duplicate of 30 Fig. 8; and in such joints, I provide at top or bottom or sides a suitable hole, with inclined sides 34, to receive and place therethrough hermetically sealed into the joint the nozzle N^1 of blower pipe B or a branch thereof, to further reinforce the pressure of the gases to propel the powders; and which nozzle is in some cases supplied with means to electrically connect with E_2 or E_1.

I conduct the process as follows:

The solids are first crushed, in a rock crusher or the like, so as to pass through a ¾ to 1 inch orifice or screen; and then dried to about 1% of moisture or less, in a direct heat contact drier in order to permit of ready pulverizing; and then pulverized to a powder, in a suitable insulated grinder or mill to increase the electrostatic capacity and the adsorption surface and the capillarity, advantageously to a fineness so that about 85% or more will pass through a 200 mesh screen and about 95% or more through a 100 mesh; a well known form of separator or separator and powder collector and a second impalpable dust collector is advantageously used with the pulverizer. It has been calculated that the surface of a one inch cube solid is thereby converted into surfaces aggregating over eight square feet. The powder may be carried to bins, from which it is fed to the electrifier conduits as in Fig. 3 and compounding chamber as required under positive control; though I advantageously grind and feed direct from the pulverizer into the electrifier conduit as in Figs. 4 and 5.

Where the feeding of the powder is by the well known feed-screw method which may be used from storage bins, the number of revolutions per minute of the feed-screw regulates the supply of the powder. The supply of the gas is controlled by gates or by fan speed of centrifugal pressure blowers or the like or both. The operator adjusts these factors together with the source of exterior heat to the temperature desired in the electrifier and compounding vessel during the operation, as determined by pyrometer, gaged in accordance with the temperature found empirically to give or produce the desired resulting compound as herein stated.

The heating of the electrifier conduit is advantageously by any of the present means Y not shown in detail for heating retorts as by gas, hot blast or other fuel flames applied to the exterior of the conduit analogous to the heating of retorts.

As shown in Fig. 3, the stored previously-ground powders are allowed to gravitate from the powder storage tank or bin such as D^2 advantageously through a conveyer screw *ps* to an air-closed bin D whence the powders fall by gravity and are sucked into the electrifier conduit P by the suction of the pressure gas feeder through Venturi nozzle N or the like, and in which conduit P the powder is thoroughly commingled with and carried by the pressure primary gas from conduit B^1 and blown thence into the compounding chamber V or equivalent furnace or retort where additional or secondary hot gases are also advantageously introduced to complete the reaction or compounding of the powders and gases; such being advantageously introduced on lines across the powder blast line through several jet nozzles N^5 to create swirling rotating motion or eddy action in the chamber.

I provide adequate control of the temperature by providing in the supply pipes of both the gas and the powder, suitable gates or stop-cocks not shown to cut off all or any portion of each; and thereby determine empirically the amounts of each and temperature required to attain the desired resulting compound. I advantageously provide several secondary and the principal gas supply pipes at different points along the length of V, constituting successive zones for due reaction or adsorption, etc. And likewise I may use in successive zones several powder injectors using same kind of gas for the pneumatic injection thereof.

I provide means of control of the quantity of powder and of gases injected to attain a desired compound reaction. Where the reaction is endothermic, and where there is a danger of having the temperature rise above the point where back action or disintegration would result (as for instance, over 1400° C. for cyanamid) in addition to the above means, I increase the gas pressure and advantageously provide a series of cooling tubes not shown, as of flowing cold water through the compounding vessel V to lower the temperature.

When temperature is too high or reaches destructive limits, I reduce the exterior heat or I introduce excess of cooled gases by well known means, not shown, or increase the amount of powders introduced as by manipulating the cut-off gates from the supply source. In other words, increase the ratio of powder to gas to reduce the temperature; and conversely if the temperature is too low or less than the reaction temperature, I increase the influx of hot gases or increase the exterior heating or reduce the supply of powder.

If the temperature employed be higher or becomes beyond the control and higher than the fusing temperature of the product,—as for instance: about 499° C. or over for crude calcium nitrate or the favorable reaction temperature of calcium carbid with N gases, which is about 700 to 1100° C. depending upon the pressure,—then it is manifest the product or some of the compound would melt or fuse, and then I withdraw the fused portion by gravity and suitable exits O_2 and which is allowed to cool and then re-ground or pulverized for use as fertilizer. In such cases a type of compounding vessel like the reverberatory or other metallurgical furnace is advantageous, with like means of withdrawing the molten product.

Before attaining a desired satisfactory product the conduits and the compounding chamber refractory lining is advantageously uniformly heated to avoid chilling the injected powders and gases; therefore the first product obtained, until chamber is duly heated, should be reworked or again similarly put through the process.

As an alternative method, I also inject the powders previously electrified as herein described, with one sign, into a closed furnace chamber, holding the gases under pressure previously ionized and advantageously electrified with opposie sign as described and all under insulated conditions and under air-tight conditions.

It will be understood that the nitrogen gases used may be such as are at present used either from arc furnaces or producer gas furnaces or from air and the like, the free oxygen thereof being removed by well known means as described, prior to use in the electrifier conduits or the compounding vessel.

To electrify the gases negatively, I advantageously use the ultra-violet light ray or high tension violet ray as at U. V. Fig. 3, with an electrifier plate p^4 in the conduit electrically connected with +G E^1, said plate and conduit being made advantageously of an alloy of K and Na: or amalgam of K or Na or Mg or Zn; or pure copper or the more electro-positive metals, advantageously as in the volta series, for contact electricity which most readily lose negative electrons; such electrifier plate being in series in a D. C., circuit with the positive earthed +G E^1. Though other metals may be thus used the above named are superior in emitting a greater number of negative electrons, I advantageously use any arc lamp as the source of U. V. light, or a mercury vapor lamp in quartz tube; or spark across air-gap through which a series of condenser discharges takes place. I conveniently use an arc-lamp with direct current supply.

It will be understood that I may use any other well known method for ionizing the gas or putting same in a conducting state; and thereafter neutralizing or leading to earth therefrom electrons of the one sign not desired, and leaving the gases charged with the other sign, as desired. But it has been demonstrated that U. V. rays are more efficient than Roentgen and other rays in promoting chemical action. When I use U. V. rays or Roentgen rays and the like for ionizing the gas, then I may electrify the tubes or conduits with lower potential say about 50 V. or upward; though the higher potential of E^1 or E^2 is more advantageous especially for sur-charging the particles.

By the term gases and ionizing gases, I include atmosphere or air; but herein, in this process, for fixing nitrogen ggas, such is advantageously freed from oxygen as described; when such is subjected to the ionizing process described there is some disruption and ionization of some of the nitrogen-molecules of the air and thereby and the surcharging by using E^1 or E^2 applied to B^4 and B, their combination is facilitated in the compounding process described. Before using such herein, I remove the free uncombined oxygen as described.

It is advantageous to use centrifugal air compressors at high speed to compress the air or gases to force same into the ionizing chamber and the electrifier conduit, and compounding vessel. The greater the pressure or ensuing density of the gas, the more ions and the greater the electrostatic capacity and the amount of electrification thereof.

With the centrifugal pressure blowers, I advantageously use a pneumatic pressure of sixty pounds upward per square inch in the transporting of the powders into and through the electrifier conduits; with renewal of the pressure with different successive supplies of the pressure gases; and in such conduits, it will be understood that there is also an electrical pressure therein, also in the compounding vessel due to the difference of potentials of the components and the electrical forces used.

All such pressures due to electric forces and heat expansion forces and pnuematic forces effect increased density in the compound molecules, which result in increase of stability and in diminished hygroscopic property in the finished product; and in addition, the compounding of the powders while suspended in the gases result in homogeneity in the finished product.

Where there is no resulting detriment, it is advantageous to spray a salt or acid solution into the gas to increase the number of ions and capacity for electrification; as shown at S Fig. 3 from a suitable vessel source S^1.

I advantageously use such salt or acid which is advantageous for or in a fertilizer, and which may be of the same character as the constituents of the final product to be attained; thus, in this case, a soluble lime salt or dilute nitric acid or dilute nitrate of lime, of one tenth normal solution sprayed through S Fig. 3 into the air entering the ionizing chamber U^1 V^1 or I may use an alkaline sulfate such as sulfate of potassium or of magnesium which tends to diminish the deliquescent property of the product; or I may use a phosphoric acid, or other acid or salt of a well known fertilizer element; I advantageously use such sprays only in the final conduit B preceding entrance to the compounding chamber, as shown at S Fig. 3.

Among the common elements having the most pronounced tendencies or affinity to combine with nitrogen gas, and which elements are also advantageous in a fertilizer, are calcium (Ca) and magnesium (Mg) and to a lesser degree the oxids or carbids of such elements. Therefore, I advantageously employ such or comparatively low priced natural compounds thereof, such as lime or calcined dolomite or calcined magnesia in my processs to make a crude compound fertilizer, with nitrogen gases as described.

Calcium fuses at about 805° C.; and CaO at about 2565° C.; magnesium at 651° C.; magnesia MgO at about 2771° C. and calcium nitrate $Ca(NO_3)_2$ at about 499° C. Potassium nitrate fuses at about 341° C. Therefore, I provide means for withdrawing the fused product, where higher than fusing temperatures are used.

It will be understood that when a fused or molten product is attained and withdrawn during the process, as described, such is cooled and powdered or crushed and packaged for use as fertilizer substantially as at present.

The advantageous temperature for chemical reactions of sundry bases with nitrogen has been found to be about 1050 to 1100° C. at atmospheric pressure,—though in many cases commencing at a lower or glow temperature; and when the temperature increases to about 1400° C. or glass making temperature, which I generally avoid,—there is a reverse effect in many cases as with calcium cyanamid resulting in a decomposition of the product attained at lower temperature. On the other hand, the products thus produced, generally melt or fuse at much lower temperature *i. e.*, $Ca(NO_3)_2$ at about 499° C.; therefore provision is made as described for withdrawing the fused or molten product from the compounding vessel with its higher temperature to attain the further chemical reaction with non-fused powder and from the electrifier conduits, when the temperature therein accidentally exceeds the melting temperature of the product and in which, *i. e.*, the electrifier conduit I advantageously use a temperature below the melting temperature of the product in order to keep the surfaces dry and clean to permit of contact with the powders for the electrification thereof; and bearing in mind further that in addition to forming compounds by chemical reaction, there are also formed at lower temperatures compounds by adsorption advantageously of oppositely electrified components or of one electrified component with a neutral gas, facilitated in some cases by capillarity. Therefore I construct the electrifier conduits for powders and gases combined, and the compounding vessels, with means of withdrawing from the bottom as at O_2, as in certain types of reverberatory furnaces, the molten products which flow thereto by gravity; and further it is advantageous to construct such of well known tubular egg-shape or catenary cross-section, not shown, with doorways O_2 from the bottom apex; and further with a downward inclination of the whole along the length and advantageously with a gutter along the bottom to suitable openings or exit pipes O_2 with shut off valves, so that with such inclination the flow of molten products will be down the sides and along the inclined gutter to O_2. Such catenary (cross section) construction and inclination of the whole is also advantageous for like reasons for the electrifier conduit with an acute angle bottom apex to serve as a gutter, and a similar exit valve or gateway O_2 at the lower end of the conduit; and in some cases at the opposite or upper end having an entrance for a blower nozzle to further assist in moving the powders.

I adapt my said process improvements to present process also of making a crude calcium cyanamid fertilizer and the like, starting with a powdered newly made calcium cyanamid, or a dried powdered CaC, and same above N gases and conducting the process as above described.

In what is known as the present cyanamid process, calcium carbid, (CaC_2) is the starting point; this is ground fine, to the consistency of flour, out of contact with the air and a portion of the ground mass is ordinarily heated in a stagnant state to a red heat or about 1100° C. in order to start the action or reaction, by the absorption of the N, gas, then duly added, under pressure, in said furnace in order to form calcium cyanamid.

In the said cyanamid process, the reaction is generally as follows:

$$CaC_2 \text{ plus } N_2 = CaCN_2 \text{ plus } C.$$

In what is known as the present "Odda" process of making cyanamid from masses of solid crushed calcium carbid, CaC_2 and N_2 the absorption of N proceeds 30 to 40 hours in a closed vertical retort holding 300 to 500 kilos and heated by an electric current to about 1000° C. through carbon rods placed inside, acting as a heating resistance; after the absorption has begun the heat is turned off. The cyanamid formed is removed in a solid coke-like block after cooling in a current of cold air about 9 hours; and is then ground to a fine powder in an air-tight grinding mill; then stored in a large silo until needed; and is then packed in a double bag or other suitable package for shipment. My process saves very many hours in the absorbing of the N gases and in attaining a purer product.

In the principal other methods now used for making calcium cyanamid, as at "Piano D'Orta" a stream of nitrogen is introduced into and absorbed by powdered stationary calcium carbid in a horizontal retort, similar to retort used in making coal gas, heated in a gas-fired furnace; $CaCl_2$ or CaF_2 is often added to the crushed CaC_2 so as to lower the temperature of the reaction to 700 to 900° C.; the favorable influence thereof, it is alleged, is due to the fact that $CaCl_2$ or CaF_2 mixes with the cyanamid formed on the surface of the carbid, and causes it to fuse at a lower temperature and thus permit the entrance of N into the interior of the carbid. The disadvantage is that $CaCl_2$ makes the product hygroscopic.

It will be noted that in the said and other present processes, the calcium carbid and the like or other base, is a stagnant or stationary mass, though first pulverized in some cases, whereas on the contrary in my process, such, in powdered form, are in suspension in, and moving in and with the gases. One step of my improvement consists in moving and blowing the above pulverized particles into a state of suspension, continuously, and by utilizing the above nitrogen gases as a carrier for moving the powders and suspending same therein, so as to surround every particle of the powders with the same gases to be compounded therewith, and advantageously previously oppositely electrified,—the combination, absorption, adsorption and reaction being attained in the state of suspension, and while the particle is moving in the gases, the combination being effected under the electrical forces of the opposite charges which result in material pressures, attaining in the product increased purity and density, which results in increased stability and diminished hygroscopic property. I likewise treat a pulverized raw or newly made calcium cyanamid, for incorporation into fertilizer compounds, as an improved calcium cyanamid.

In Fig. 4 is shown the means for application of the process to phosphates and the like which emit positive electrons when heated; though it will be understood that Fig. 3 can be likewise used by merely changing the grounding switches of E^1 or E^2 from negative, as shown in Fig. 3 to positive ground in Fig. 4.

The soluble phosphate, mono-calcic phosphate or the tri-calcium phosphate prepared as at present from rock phosphates, which, as found in nature, often contain 70 to 78% phosphate of lime, and whereof the calcium portion has a material affinity for N, can be similarly advantageously electrically treated like the above quicklime to combine or compound with nitrogen gases; but when such calcic phosphate is pulverized and thereafter heated as a powder in the electrifier conduit, it emits positive electrons which are earthed through +G E^1 or +G E^2 of Fig. 4, and the powder itself is left charged negatively; and thereupon is brought into contact in the electrifier conduit P^2 and P and P^1 and in the compounding vessel V with the X gases which may be neutral or advantageously previously charged positive in B and B^1 Fig. 4, that is gases which are ionized as by X-rays R B Fig. 4 or Becquerel rays and the like, and then have both positive and negative electrons, and which latter are then first earthed from B and B^1 by $-G\ E^2$ or $-G\ E^1$ to ground the negative electrons. Branch gas pipes are shown B^3, B^4, B^5, B^6, B^7 from B and B^1 leading to the different conduits P and vessel V.

The conduct of the process for Fig. 4 is substantially as described for Fig. 3 with the modifications set forth in describing herein sundry novel parts shown in Fig. 4.

In Fig. 4, from a pulverizing mill 16, of the type hereafter described, fed by crushed dry stone from a bin 7, the powder is duly forced by blower Q^2 with deoxidized gas drawn from B^2 through B^9, into a centrifugal gas and powder blower Q^1 with ionized gas from B^3, direct through P^2 into a species of reverberatory furnace of three compartments or zones, P and P^1 and V, the functions thereof corresponding to P and V of Fig. 3, or P and P^1 and V of Fig. 5; but having in lieu of a conduit tube, a series of deflecting and electrifying perforated plates *p* and *p* in P, and p^1 and p^1 in P^1, against which the incoming powders suspended in gases are violently blown and deflected from one plate to the other, and from conduit chamber P into conduit chamber P^1, both lined with conductor material, and thence into compounding vessel V with similar deflecting perforated plates *v* and *v*; the chambers of P and P^1 are advantageously metal lined but the chamber of V is lined with vitreous insulator brick and the like; the metal lining and plates of P and P^1 are electrically connected with $+E^1$ of Fig. 1 and $+E^2$ of Fig. 2 respectively, to ground the positive electrons emitted by the phosphate and for surcharging the same with negative electrons; and in V the negative powders meet the secondary and main supply of positive gases from B^5, and the like entering through nozzles 5.

From V the waste or uncombined gases and some powders are blown by a suitable nozzle at N^7 with cold gases through B^8, source not shown, into a system of separators and collectors as shown in Fig. 6; or other such systems shown in diagram Fig. 4, C^1 and C^3 with exit chimney F^4 for gases and a flue therefrom F^5 to conduct the gases back for heating Q or for other use.

The vertical cross-section, not shown, of P and P_1 and V is advantageously of the well known catenary type; and with means of withdrawing from the bottom as at O_2 any fused molten compound products, to be subsequently cooled and extracted or employed as at present.

The gas electrifier conduits B, B_1, B_2 are substantially as explained for Figs. 3 and 5 and 8 and 9, but showing in Fig. 4, an X-ray ionizer R B, with details not shown, which ionizes gases with both positive and negative electrons,—and from which gases the negative are grounded in B and B_1 per $-GE_1$ and the gases proceed as described with positive electrons only.

In V sufficient heat is applied by Y to attain a combining temperature advantageously about 1050° C. or up to 1400° C.

As an alternative to P and P_1 and V in Fig. 4 such may be replaced by the revolving type of an inclined cylindrical rotatory furnace, not shown, advantageously of about 150 feet in length, with shelving riveted to the sides of the cylinder whereby the powders blown in with the gases at one end, the lower end, are gradually worked to the opposite and higher end, the powders being repeatedly showered through the hot gases in the passage until discharged therefrom, as in the manufacture of hydraulic cement.

Suitable exterior heaters Y are used as shown. In the chamber conduit or zone P are placed hot interior surfaces of conduit plates heated to about 250° to 300° C., to heat the powder to about like temperature by contact and convection of heat, and whereupon the phosphate gives off positive electrons leaving the phosphate powder negative, the positive electrons being mostly earthed through a $+E_1$ or $+E_2$ connected with the plates; and then the projected powder is blown farther into zone P_1 advantageously heated to over 400° C. with a similar $+E_1$ or $+E_2$ to ground positive. At said higher temperature both + and − electrons may be emitted by the walls and by the hot powders and whereby the powder is further surcharged negative and the positive electrons therefrom are earthed or neutralized.

I advantageously use the gases heated like by the system of the regenerative furnaces or the like, wherein a fire brick oven Z Fig. 4 is employed as a means of transmitting the heat thereto of the furnace gases or waste gases brought to Z by pipes not shown from F^5, *i. e.*, by passing the waste gases, etc., through large ovens or chambers containing great masses of fire brick shown in diagram at Z Figs. 4 and 5, heated red hot; cold gases or air or both are then turned into the oven and the gases are therein heated. A hot blast temperature of 600° C. (1110 F.) is thereby readily obtainable. In some cases, the producer gases and the like are advantageously previously compressed by blowers and collected in receivers or gasometers G.

In some cases such compressed gases from gasometers may also be heated by passage through a series of iron pipe not shown, advantageously elliptical in cross-section, size 3″ x 18″ x 10′ subjected on the outside to heat from any source; but in such case, as iron pipe burns through,—the blast therefrom is restricted to 300° C. (570° F.).

I also adapt my process to sundry fertilizer components obtainable from industrial wastes, such as finely ground basic slag from blast furnaces in the preparation of steel from high phosphorous pig iron, which slag often contains 11 to 23% phosphoric acid. And likewise, I utilize pulverized bone-ashes which consist mainly of phosphate of lime, $Ca_3(PO_4)_2$; or the superphosphate of lime made therefrom with sulfuric acid to wit,

$$Ca_3(PO_4)2+2H_2SO_4=2CaSO_4+CaH_4(PO_4)_2$$

In my process, in some cases, in the pulverizing of solids, I advantageously use a style of pulverizer which permits of operating or conducting the pulverizing under what I call air-free conditions, *i. e.*, to exclude as far as practicable the entrance of air and more especially of free oxygen; and this I attain approximately by having closely fitting joints of present pulverizers, using washers at the joints to hermetically seal same; and further feeding the coarsely crushed solids into the pulverizer through a bin 7, which after being filled with the crushed solids is closed with a hermetically sealed cover 8.

I use the term "to exclude air" or to "operate under air-free conditions," and the like, to mean making the compounding vessel and conduits and connections hermetically sealed by well known means so as to exclude air, except at the outlet from the compounding chamber V for the surplus gases and powder product, during the continuous process; and even there the gases have sufficient velocity and pressure to prevent the ingress of outer air. By the term "under air-free conditions" herein I also include free from oxygen as nearly as practicable.

Though I may use other types of pulverizers, I advantageously use the type of pulverizing machines of the rubbing and abrasion present mill type, which roll and mash the solids between hard surfaces, as of non-conducting grind stones, quartz or sandstone and the like, as shown at 16 Fig. 4, and under insulated conditions supporting the whole mill on insulators; and thereby some of the frictional or static electric charge resulting upon the powders from friction in the pulverizing will continue therewith when the powders are fed into the electrifier conduit and compounding chamber.

Or I may use insulated pulverizers of metal of the swing-hammer or striking type as shown at 18 Fig. 5,—or the ball-mill type, as distinguished from the rubbing and abrasion mills which roll and pulverize between hard surfaces as shown at 16 Fig. 4, and which latter may also be of metal on insulator supports.

I advantageously use a pulverizing mill of the type which also has therein a separating chamber as 14 Fig. 4, advantageously immediately above the pulverizing zone, and a gas compression centrifugal blower Q Fig. 4 fan in or connected with said chamber to lift the powder from the grinding zone into said chamber thence into the electrifier conduit.

I advantageously electrically connect the metal frame and machinery of the pulverizer, supported on insulators, with a set of the electrifier apparatus of Figs. 1 or 2; as shown at $+GE_2$ of pulverizer 16 Fig. 4, or advantageously $+E^2$, which illustrates the grinding of phosphorous compounds in a dielectric stone mill, whereby positive electrons are emitted and largely grounded; and also shown $-GE_2$ of pulverizer 18 Fig. 5 or advantageously $-E^2$ where lime and like is pulverized emitting negative electrons which are largely simultaneously earthed; and to some extent additional electrifications of the oppositely charged solids are simultaneously thereby obtained; and by the general term electrifier conduits, I include such mills therein. It will be understood that I may adapt and apply E_1 in lieu of E_2 throughout.

Q_1 in Figs. 4 and 5, is a diagram of a centrifugal powder and gas pump or blower, with revolving arms; with insulator supports I, analogous to and an adaptation of the present centrifugal sand pump, in combination with electrifier apparatus E^1 or E^2 applied to the metal centrifugally revolving impellers or arms and framework; and which centrifugals are similarly advantageously placed in the conduit P system, as a portion of said latter and advantageously similarly heated, for due electrification or further electrification by unipolar contact, of the powders from any supply source passing therethrough, and for increasing the velocity thereof and increasing the pressure and the force of impact of the powders against the electrifier surfaces in the pump and the conduit and in the compounding vessel. And likewise utilizing a similar centrifugal compressor gas blower BQ^1 in the gas conduits B, to attain unipolar contact in and through the blower.

Fig. 5 is a diagram of my improved means and process as applied where two different solids are used in and for compounding with and to fix nitrogen gases and the like, such as for making crude cyanids, or in what is known as the cyanid process, where pulverized soda-ash (carbonate of soda) and finely powdered coke, and iron as catalyzer, are mixed with or brought in contact with nitrogen gases, advantageously at high temperature, up to about 1050 to 1100° C., but less than the melting point of either component.

In the cyanid process, the reaction is generally as follows:

Na_2CO_3 plus 4C plus N_2=2NaCN plus 3CO.

Heretofore cyanogen compounds and the like have been or are made largely, by electrical heating or non-electrical heat of very high temperatures as per sundry old processes, acting upon stagnant mixtures of compounds towit: pulverulent coke, or graphite or charcoal, or coal or the like, intimately mixed with another component, sodium carbonate or other alkali base of the cyanogen compound sought, together with finely divided iron and the like as a catalyzer; all previously mixed and in stagnant mass in suitable retorts or vessels into which is forced nitrogen-containing gases, under more or less pressure either N from air or N compound gases from coal and the like.

In applying my improvement for cyanids to make a crude product comprising cyanids, which can be extracted from the product as at present, I advantageously pulverize the two different solids separately giving the same opposite electrifications as above described, and then mix the two powders under insulated conditions, or advantageously feed the two powders, in due proportions as per the above or other formula, simultaneously similarly into the electrifier conduit P of Fig. 3 or into P and P^1 respectively of Fig. 4, and the like and thence into compounding vessel V, with ionized N gases having both positive and negative electrons, as when ionized by X-rays and the like. Or as an alternative in lieu of above, I advantageously apply the process by the means shown in Fig. 5, which in fact combines two sets of the electrifiers P and B for solids and gases respectively of Fig. 3; namely, one called the primary set for the one powder, such as soda ash and the like to wit, positive conduits +P and $+P_1$ with its accompanying negative ionized gas conduit, −B, and connections as shown; the catalyzer powdered iron is advantageously fed into P_1 by a branch gas blast from Q_2 and pipe B B and blast powder and gas nozzle N^3 like Fig. 7 injecting iron powder drawn from bin D_4; and the other set of conduits called the second set, for the other or second powder constituent of the compound desired, such as graphite and the like, with the powder electrifier negative conduit $-P_3$, and its accompanying ionized gas conduit $+B_4$ and conduit $+B_5$. The conduct of the process is substantially for each set as above recited for the single set process of Figs. 3 or 4; and the exterior heater "Y" of P_3 is turned off or advantageously dispensed with, after heating same thoroughly at the beginning of the electrifying the graphite or other carbon used, and after such separate opposite electrifications of the two different powders, the former being electrified with far higher voltage than the latter, they are further separately injected together with the secondary supply of gas $+B_5$ and $-B_6$ (the latter being a branch not shown from −B) into the compounding vessel V, as shown in Fig. 5; all nozzles into V being advantageously of the well known centrifugal type, not shown in detail.

In Fig. 5, I ionize the gases negative for the one above or primary set, and positive and negative for the second or other set by means of X-rays or Becquerel rays and the like, shown at R B in conduit B_3 and with main branch B_5, from which I ground the negative electrons by means of $-E_2$ and whereupon the gases proceed with positive electrons only or in great excess.

The gases for conduits −B and $+B_5$ are advantageously drawn from the common source of gases or gas reservoir not shown, through a heater Z, by blower Q through the free oxygen extractor Q C and the like, and suitable pipe connections as shown and the careful hermetic sealing to prevent air ingress therein. I have elsewhere herein described the other parts of apparatus shown in Fig. 5 and the similar application thereof, as likewise used in Fig. 5, and the analogous conduct of the process. The cyanid from the resulting product being soluble in water is separated from the residues of the compounding, by lixiviation as in present methods.

I do not restrict my process solely to the use of the catalyzer as described in Fig 5. It will be understood that in the processes herein described for compounding one solid with the gas, as illustrated in Figs. 3 and 4, a pulverized catalyzer may in some cases, also be similarly advantageously introduced and used, as illustrated in Fig. 5.

I may also similarly introduce the powder catalyzer with a separate gas circuit not shown, such as B_5 in Fig. 5, advantageously direct into the compounding vessel, while the other powders are being simultaneously similarly forced into the said vessel.

It will be understood that any of the solid catalyzers heretofore used in such or similar reactions may be likewise advantageously used by me in powdered form as herein described.

From the crude product, thus obtained and which includes the catalyzer, I separate and prepare and again utilize the catalyzer, in the manner now commonly used; and generally by lixiviation to dissolve the nitrogen product and the like, and recovering from the solution the nitrogen product as at present. Such catalyzers are advantageously powdered or crushed coarser than the solids to be compounded,—advantageously to about 60 to 70 mesh.

I likewise adapt the process to make a cyanid from barium carbonate, and graphite or coke, etc., and N gases, first making a crude barium nitrate product; when cooled the same is treated as at present towit:

The product is lixiviated with water, and the resulting solution, barium cyanid and hydroxid is treated with sodium bicarbonate, resulting in a solution of sodium cyanid, which is concentrated by evaporation in vacuum,—thence passed over cooling coils resulting in a depositing of crystals of the hydrate $NaCN_2H_2O$, dehydrated by heat and then briqueted or pulverized.

I likewise adapt the process described in connection with Fig. 5, for the manufacture of a nitrolime of a crude calcium cyanamid $CaCN_2$ from lime, in lieu of calcium carbid, towit: compounding

$$CaO+2C+N_2=CaCN_2+CO$$

using the apparatus of Figs. 5 or 3 as described, but at materially high temperature, in the compounding vessel V.

And likewise in making a crude magnesium and nitrogen fertilizer from powdered magnesium oxid advantageously caustic calcined magnesite and graphite or coke, and N gases.

Likewise, in making cyanids from N gas and powdered potassium carbonate and carbon at a glowing temperature to form KCN, a very old well known combination.

In my improved process, I advantageously use a temperature in the electrifier conduits and connecting piping less than the melting or fusing temperature of any of the components and less than that of any product of the components passing therethrough; and I use a higher temperature than such in the compounding vessel where such higher temperature may be found empirically to be essential to attain the desired compounding or reaction.

Where air only is available in lieu of producer gas and the like, or arc-furnace N gas, I use such in like manner but at slightly higher temperatures of about 100° F. higher. When the air is forced through the charcoal- or copper-holding conduit Q C advantageously heated to about 1100° F. or 600° C. or even at about 570° F. or 300° C. the charcoal combines with the oxygen of the inflowing air so that a mixture of CO and N gas with possibly some little CO_2 is forced onward into the conduits P, and compounding vessel V wherein most of the N is combined with the powders, and the CO and uncombined N passes off with the waste.

I also adapt my process, as described, to sundry potash fertilizer components, advantageously obtained, economically from sundry industrial wastes, including potash from the Portland cement manufacture, where it escapes from the kilns with the flue dust. In my process, I advantageously may utilize the said cement dust without separating the potash, I blowing such dust through the conduits, etc., with N gases advantageously with powdered CaO as described, each component being previously oppositely electrified; the N gases are thereupon electrically adsorbed by and with the K containing dust; and which electrical adsorption results in a stable physically fixed compound.

And likewise I utilize pulverized hardwood ashes containing 5 to 10% potassium carbonate K_2CO_3 which is soluble in water; and likewise pulverized sugar-beet ashes and other root-crop ashes, which are rich in potash, advantageously with a component such as CaO powdered, which has a distinct affinity for N. And I likewise utilize other suitable potash sources, notably pulverized glauconite or greensand, which also contains calcium phosphate. And I likewise use pulverized sericite or potash-containing slates, advantageously calcined; and other potash-bearing rocks including the leucite.

It will be understood that the compounding vessel V is advantageously quite long, advantageously 100 or 200 feet or more in length; and advantageously constructed like a catenary dust-flue from metallurgical furnaces, or balloon-shaped in cross-section, lined with refractory material; and using similar means for retarding the gas-current such as enlarging the volume of the flue-like vessel, changing the direction thereof and increasing the contact surface; and using similar dust-separating devices.

In the compounding of sundry commercial fertilizers, there are now mixed with the fertilizer components proper, sundry admixtures or fillers of natural substances such as sand used for their mechanical effect; or natural fertilizers such as marl, peat, loam, lime, wood-ashes, and others, used for mechanical and in part fertilizer effects; and all of which I call fillers.

I advantageously mix any such desired in the formula, by analogous process and apparatus, *i. e.*, by drying and pulverizing same and blowing same advantageously with the pulverized fertilizer components and the N gases as described, into the end sections or zones of the long compounding vessel such as V Fig. 6, through suitable similar twyers and nozzles as described but without heating or electrifying same, *i. e.*, introducing such admixture powders cold and in streams entering cross-section and as counter-currents, as through nozzle N_8 Fig. 6 and others not shown, along the sides, or across the direction of the hot gases and hot powders, so as to check the velocity thereof and also through nozzle N_7 projecting into the outgoing hot stream into pipe F and the separators and collectors C_1, C_2, C_3; such cold stream will cool the hot stream and simultaneously cause a mixture and blending more or less uniform of the fillers or mechanical components with the fertilizer components; the mixture being withdrawn as heretofore described, as from O_3, O_4, O_5 and the like of Fig. 6.

It will be understood that a similar blending and mixing of any existing cold fertilizer components and fillers may be likewise mixed, *i. e.*, by drying and pulverizing and injecting such separately in powder form, in the proportions desired in the formula, and with compressed pneumatic air substantially as desired.

And likewise in the compounding of a solid component with gases in the presence of a solid catalyzer, the latter advantageously neutral and not electrified. I pulverize all the solids and force, mix, blend and suspend the powdered solids with and into the gases, under suitable high pressure. At high reaction temperatures in suitable vessels, substantially as above described; and completing the compounding and the withdrawal of the catalyzer in some cases, as when not a fertilizer, from the resulting compound, substantially as at present. It has been demonstrated that refractory materials as well as metals, when red hot or at higher temperatures, act catalytically; and where such are also capable of acting as a useful component in the resulting compound then such is retained therein; as for instance calcined magnesia is advantageous in the above process for fixing nitrogen from air and gases in that at the higher temperatures of the process it does not decompose or melt but continues to act catalytically to fix the nitrogen and is retained as a component of the crude nitrogenized calcined magnesia fertilizer.

Fertilizers are advantageously marketed in powdered form; it is important that compounds should be uniformly mixed. With present methods of mixing sundry compound fertilizers, it is difficult and generally impracticable to obtain uniformity, and with the result that the same fertilizer when applied to one part of the soil, is different from that applied adjoining thereto; and whereupon the several plants are not nourished alike, as intended, *i. e.*, do not have the opportunity of imbibing similar solutions of fertilizers. I largely overcome this difficulty, and attain a far more uniform mixture by applying my process and apparatus as described.

I also use such advantageously without the use of heat where such may be injurious, as with pulverized tankage and fish scrap and without the use of electrical forces nor nitrogen gases, where there is no chemical compounding involved but merely a mechanical mixing as of sundry present solid well known fertilizer components of N, and of K, and of P, and the like with or without the adulterants or fillers such as sand, etc., I pulverize each such separately, and inject the same with compressed air in separate streams simultaneously, in the proportions prescribed in the desired formulas into the compounding vessel from which and the adjoining collectors and separators the same are withdrawn substantially as described.

I do not restrict my improved process to the means and apparatus described; but may use other means to attain suspension and movement and contact of powdered solids in and with gases—under suitable pressure and temperature and air-free conditions, after previous opposite electrification of the components or one or more thereof and may also use other means to attain such electrifications, all under insulated conditions.

As regards other means not shown, to attain suspension and movement and contact of powdered solids in and with gases, I include:

(*a*) Present means of injecting a stream of powder into a closed furnace of compressed gases, analogous to present means of injecting sprays into such; and to which I add means to attain operations under insulated conditions; also

(*b*) Present means of injecting powders and gases into a rotatory furnace analogous to like means used in one process of making Portland cement; and to which I add means to attain operations under insulated conditions; and

(*c*) Present means of sifting powders through a sifter or sieve in the top of a furnace and the meeting therein of gases injected upward from the bottom thereof; and to which I add insulator supports and due means to operate under insulated conditions.

As regards other means not shown, to attain electrification of powders, and gases separately, I include:

(*d*) The electrification of dry powders upon sifting same through a metallic sifter or sieve in the top of a furnace which sifter is in series with the above electrifier apparatus electrically connected therewith and with one pole or alternation earthed; and with means for injecting gases into the bottom of the furnace, and the like, all under insulated conditions; also

(*e*) Other means not shown, of ionizing gases.

I do not restrict the process to make a crude fertilizer compound to a compound of lime and nitrogen onl· ; but may use other basic pulverized elements and compounds, with nitrogen gases, soluble in water, as of magnesia, phosphorus, potassium, and aluminum.

I am aware that quicklime briquets have heretofore been treated for absorption of N gases to form calcium nitrates and nitrites (Schloessing's method and others).

Likewise in the cyanid processes such as in the manufacture, heretofore, of cyanid from barium carbonate or lime, and carbon and nitrogen gases; and in the cyanid processes such as soda ash or other alkali carbonate plus finely powdered coke plus nitrogen gases with iron or copper as catalyst; and in the present methods of manufacture of nitrids of sundry metals A^1, etc.

And I do not claim such combination or old treatment of briquets and the said compoundings. But it will be noted that my method differs in that I treat the same solids in powdered form in suspension in the gases; advantageously with ionized gases preferably additionally charged; and with the powders oppositely charged, and under insulated conditions.

I claim:

1. An electrical treatment in the compounding of solids with gases, which consists in drying and pulverizing the solids, and in electrifying the solid powders and gases separately and with opposite signs and of different potentials, and thereafter compounding the same while the powdered solids are suspended and moving in the gases; all under insulated conditions and under air-free conditions.

2. An electrical treatment in the compounding of solids with other components, solid and gaseous, which consists in drying and pulverizing the solids, separately, and in separately electrifying the powdered solids with opposite signs and of different potentials, and thereafter compounding both solid powders with the gases previously ionized, and while suspended and moving in the gases; all under insulated conditions, and under air-free conditions.

3. An electrical treatment in the compounding of solids with gases, which consists in the drying and pulverizing the solids and in electrifying the powders with one sign only, and thereafter compounding the components at high temperature while the powders are suspended and moving in the gases; all under insulated conditions, and under air-free conditions.

4. An electrical method of compounding solids with gases, which consists, in drying and pulverizing the solids, and electrifying the powders and gases separately and with opposite signs with a higher potential in the positive, and thereafter compounding the same while the powders are suspended and moving in the gases and in successive zones of increased temperature and pressure both pneumatic and electrical; all under insulated conditions, and under air-free conditions.

5. In the compounding of solids with gases, the additional steps comprising the drying and the pulverizing of the solids, and the separate electrifying of the powders and the gases, with signs opposite to each other, and with a higher potential in the positive than in the negative; and thereafter compounding the components at high temperature while the powders are suspended and moving in the gases; all under insulated conditions.

6. In the compounding of solids with gases, an electrical treatment comprising the drying and pulverizing of the solids, and separately electrifying the powders with a charge whose potential is in excess of the dissociation voltage of the combination and the resistivity of the gas; and thereafter compounding the same at high temperature and adequate pressure while the powders are in suspension in and moving in and with the gases; all under insulated conditions and under air-free conditions.

7. An electrical treatment in the compounding of solids with gases in the presence of a solid catalyzer, which consists in drying and pulverizing all the solids separately, and electrifying the solid powders to be compounded, and the gases separately with opposite signs and of different potentials; and thereafter compounding the same while the solid powders are suspended in and moving with the gases, and in the presence of the catalyzer in powder form similarly simultaneously suspended in and mixed with the powdered solids and gases being compounded; all under insulated conditions and under air-free conditions; and thereafter duly separating the catalyzer from the desired compounded product.

8. A process for nitrogen fixation consisting of electrifying with opposite signs nitrogen gases, and separately a powdered suitable basic solid having an affinity therefor; and thereupon compounding such at high temperature and pressure; all while the powders are suspended in and moving with the gases under insulated conditions and under air-free conditions.

9. In the compounding of solids and gases, the process which consists in pulverizing the dry solid under insulated conditions so as to

retain the frictional charge on the powders, and further electrifying the powders by subjecting same to high temperature to insure emission of electrons; and further electrifying the powder by unipolar contact; and with the due simultaneous earthing of emitted electrons of opposite sign; and thereafter bringing the electrified powders into contact, under insulated conditions, with the gases previously ionized and oppositely electrified, and with the powders suspended in the gases; all under insulated and air free conditions.

10. In the compounding of pulverized solids and gases, the step of electrifying the solid with one sign only which consists in conducting the pulverization of the dried solid under insulated conditions and the simultaneous earthing of emitted electrons of opposite sign.

11. In the compounding of solids and gases, the step of electrifying the solid in pulverulent form with one sign only which consists in conducting the pulverization of the solid under insulated conditions and in further electrifying the powders by heat and by unipolar contact and the simultaneous earthing of emissions of electrons of the opposite sign, all under insulated conditions.

12. In the compounding of solids and gases, the step of electrifying a dry pulverized solid with one sign only, which consists in combining electrification by friction in the pulverizing, with electrification by heat emissions of electrons, with electrification by unipolar contact with an electric supply circuit, with the simultaneous grounding of emitted electrons of the opposite sign; all under insulated conditions.

13. In the compounding of solids and gases, the step of electrifying and surcharging gases with one sign only, prior to the compounding, by first ionizing same and then electrifying the ionized gases by unipolar contact and simultaneously earthing therefrom of the electrons of opposite sign; all under insulated conditions.

14. In the compounding of solids and gases, the process step of electrifying materials in suitable form by unipolar contact with one alternation of each cycle of an alternating current circuit, the other alternation being automatically grounded; all under insulated conditions.

15. In the process for the purpose stated, the step of electrifying a material with one sign only and from alternating current supply, which consists in bringing the material in powder form under insulated conditions into contact with a conductor conduit plate or the like heated to a high temperature, and which is in series in an A. C. circuit of a suitable voltage and constant amperage, having its alternations of opposite sign grounded in synchronism with the same A. C., and with a substantially increased difference of potential between the electric source of supply and the said conduit plate and the like.

16. In the process for the purpose stated, the step of electrifying a powdered material with one sign only, which consists in bringing same in suitable form and under insulated conditions into contact with a conduit plate or the like heated to a high temperature and which is in series in a direct current circuit having its pole of the sign opposite to the above grounded; and of a suitable voltage and amperage; and with an increased difference of potential between the electric source of supply and the said contact conduit plate and the like.

17. In the process for the purpose stated, the step of increasing electrification of a material with one sign only by contact thereof, with a non grounded terminal of an electric current circuit having one terminal grounded, and under insulated conditions which consists in increasing the difference of potential between the electric source and the contact points and the like; and in heating the contact points to high temperature.

18. In the compounding of a solid and gases, the step of pulverizing the solid and electrifying the powders with one sign only, prior to the compounding, under insulated conditions.

19. In the process of compounding solids and nitrogen gases, the step of ionizing N gases, air and the like, as at present, after the removal of the free oxygen therefrom; and then further disrupting and surcharging the nitrogen molecules by means of a high voltage unipolar contact, all under insulated conditions, and air-free conditions.

20. In the process of compounding solids and nitrogen gases, the step of electrifying and surcharging N gases, air and the like, which consists in first substantially freeing the same from free uncombined oxygen, then ionizing same as at present; and then disrupting and surcharging the N gases by means of unipolar contact with hot plates and the like all under insulated conditions, and air-free conditions.

21. In the compounding of a solid component with gases, in the presence of a solid catalyzer, the process of moving injecting and suspending both such solids in powder form into and with the gases, during the compounding thereof, at high reaction temperature and due pressure, the catalyzer not being electrified; and completing the compounding and the withdrawal of the catalyzer from the resulting compound as at present.

22. A compound fertilizer comprising a powdered positively electrified calcic phosphate of lime, and a powdered negatively electrified soluble potassium base, combined with neutral nitrogen gases freed from free

oxygen, the compounded particles having increased homogeneity and uniformity as regards content of phosphorous potash and nitrogenous fertilizer components, and with increased density and stability, and of diminished hygroscopicity.

23. A compound fertilizer comprising a powdered basic solid electrified with one sign only, combined with nitrogen gases fixed from air and the like.

24. A compounded solid and gas product, comprising a solid pulverized and electrified with one sign only, and combined with previously ionized gases.

25. A compounded solid and gas product, comprising an electrified powdered solid combined with gases, and whereof the particles are of increased density, stability and homogeneity, and of diminished hygroscopicity.

26. A fertilizer component consisting of a suitable basic solid pulverized and electrified with one sign only.

27. A compound fertilizer comprising a suitable basic solid, in powder form duly electrified with one sign only, compounded with suitable nitrogen gases previously ionized and electrified with opposite sign.

28. A compound fertilizer comprising a suitable powdered basic solid electrified with one sign only, in combination with suitable nitrogen gases fixed from air, the compounded particles having increased density, stability, and homogeneity, and of diminished hygroscopicity.

29. A compound fertilizer comprising a powdered positively electrified calcium base, combined with negatively electrified nitrogen gases.

30. A compound fertilizer comprising a powdered positively electrified magnesium base, combined with negatively electrified nitrogen gases.

31. A compound fertilizer comprising a powdered positively electrified cyanamid, combined with negatively electrified nitrogen gases.

32. A fertilizer component comprising nitrogen gases, freed from free oxygen, ionized and electrified with one sign only.

33. A compound fertilizer comprising a powdered positively electrified mono-calcic phosphate of lime, combined with ionized and negatively electrified nitrogen gases freed from free uncombined oxygen.

34. A compound fertilizer comprising a powdered positively electrified potassium fertilizer base, combined with ionized negatively electrified nitrogen gases, freed from free oxygen.

35. In an apparatus for the purpose stated, of electrifying a material with one sign only, and from A. C. source, the means of contacting the material under insulated conditions, with a conduit plate extension wire and the like in series in an A. C. supply circuit; with means of grounding the alternations of each cycle thereof, opposite in sign to the sign to be conferred on the materials; with means placed in series in the A. C. circuit, of increasing the difference of potential between the electric source of supply and the contact conduit plate and the like; with insulator supports for all apparatus; substantially as described.

36. In an apparatus for the purpose stated of electrifying a material with one sign only from direct current supply, means of bringing the material in suitable form under insulated conditions into contact with a conduit plate extension wire, and the like, in series in a direct current supply circuit; with means of grounding the terminal of the circuit of the sign thereof opposite to the above sign; with means placed in the current circuit, of materially increasing the difference of potential between the source of electric supply and the said contact conduit plate and the like.

37. A pulverizer mill and the like, of conductor material; with insulator supports; with means of electrically connecting the metal parts with one pole of a direct current supply circuit, the other pole being earthed; with means of heating the pulverizer, and means of operating the pulverizer under insulated conditions.

38. A pulverizer mill and the like; with insulator supports; with means of electrically connecting the metal parts of the pulverizer with one pole of a direct current circuit, the other pole being earthed; with insulator means of feeding the solids to be powdered, into the pulverizer, and insulated means for withdrawing electrified powders therefrom; with insulated means for blowing hot gases, air and the like into and through the pulverizer, and transporting the powders therefrom.

39. In the mechanism for the purpose described, an electrifier apparatus comprising a low frequency alternating current metallic circuit of which the earth forms no part; with one lead of the circuit connected with and having an extension trailer wire into the interior of an electrifier conduit retort and the like; with means of forcing under air-free conditions, powders and gases and any materials to be electrified with one sign only, injected from a pulverizer and connecting piping into and through said conduit and thence into a neutral compounding furnace-like vessel; with means of previously pulverizing the powders from suitable solids under insulated conditions so as in part to retain in the powders when injected into said conduit the frictional electrification due to the grinding and pulverizing; with means of heating said conduit and vessel and contents passing therethrough to a high suitable

temperature, to insure the emission of electrons from said passing contents; with means of automatically grounding such emissions; with means of controlling and regulating the pressure and temperature and velocity of movements through and within the conduits and the compounding vessel; with means of having a succession of such conduits with zones of increased pneumatic and electrical and heat pressures therein; and successive zones of diminished pressure and increased heat in the compounding vessel; and with means of control of such electricity and heat and pressures; with means of withdrawing from the compounding vessel, the compounded products fused and in powder form and waste uncombined gases; with means of controlling the voltage in said circuit and the difference of potential at the said conduits; with a shunt circuit from said A. C., circuit, having an interrupter selector therein, adjustable to pass to earth therethrough only positive or only negative electrons from each of the said conduits, such being of the same sign as the electrons emitted by heat and being of the sign opposite to the above sign of the charge to be retained by the powders and the like upon contacting with the interior of the said conduit; with resistance, inductance and capacity, and a step-up transformer, a volt-meter and ammeter and a double pole circuit breaking switch in said A. C., circuit; with insulator supports for all connecting pipes and apparatus; and dielectric joints in connecting piping to other apparatus not in and part of the electrifying apparatus as described.

40. In the mechanism for the purpose described, an electrifier apparatus comprising an alternating current metallic circuit of which the earth forms no part, in combination with a transformer to attain any desired high voltage; with a frequency converter to attain low frequency current; with means of electrically connecting in series in said circuit a suitable electrifier conduit, retort, plate, extension wires within the conduit and the like; with means of forcing therethrough, under air-free conditions, powders and gases and any materials to be electrified with one sign; with means of alternately intermittently earthing from said conduit and materials therein, the sign opposite to said sign, in synchronism with the frequency of said A. C., through and by means of a shunt from said A. C. circuit and an interrupter selector in the shunt circuit permitting only such one sign to pass to earth therethrough; with means of heating said conduit retort and the like and contents externally, to a high temperature, sufficiently high to cause the emission of electrons from the hot powders passing through the conduit, with means of earthing the said emitted electrons by contact with the inner surface of said electrifier conduit when such is a conductor and upon the extension of the wires of the circuit within the conduit; with means of placing a transformer into and out of said circuit; with resistance, inductance and capacity, volt-meter and ammeter and double pole circuit breaking switch in the said A. C. circuit; with insulator supports for all connecting pipes and apparatus, and dielectric joints in connecting piping.

41. In the apparatus for the purpose described, an electrifier apparatus comprising a direct current metallic circuit; of suitable high voltage and amperage; with means of earthing either pole thereof through a manually adjusted pole changer in the circuit; with means of connecting and placing in series in the non-grounded terminal line of the circuit, a suitable conductor electrifier baffle and the like including wires within a non-conductor conduit having connected therewith, means of forcing a flow of the material to be electrified into and through said conduit, making and breaking contact with the inner surface of the conduit rapidly and violently, and thence flowing into a compounding neutral furnace vessel; with a non-inductive resistance in series in the non-grounded terminal line; with a trailer-wire extension connected with the non-grounded lead wire in the conduit, of a form permitting the flow of the materials therethrough; with means of regulating the velocity pressure and temperature of the flow of the materials through the conduit; with means of heating and attemperating the conduit to high temperature; with means of increasing the difference of potential at or near the conduit between the conduit contact wires and the source of electrical supply; with a circuit breaking switch, ammeter, voltmeter, galvanometer and pole changing switch in the circuit; with insulator supports for all connecting pipes and apparatus.

42. In the apparatus for the purpose described, an electrifier apparatus comprising a direct current metallic circuit, of low voltage and suitable amperage, of which the earth forms no part; with means of converting the direct current to alternating current; with means of increasing the voltage of the A. C., through a step-up adjustable transformer; with means of converting the high voltage A. C., to high voltage D. C.; with a pole-changing switch in the high voltage D. C. circuit, to earth either pole of said latter circuit; with means of connecting and placing in series in the non-grounded pole line of the said high voltage D. C. circuit, sundry extension wires of the latter within a suitable conduit, and a succession of such conduits; with means of forcing a flow in suitable form of a material to be electrified into, through and out of said conduits into suitable dielectric compounding air-free ves-

sels in connection therewith; with dielectric joints for connecting the conduit with connecting pipes and dielectric sleeve supports at connections with vessel; with means of regulating, of increasing and decreasing the velocity, pressure and temperature of the materials being treated; with means of heating and attemperating the conduits and the said extension wires to high temperature; with means of increasing the difference of potential between the wires within the conduit and the electric source; with a circuit breaking switch, rheostat, ammeter, voltmeter, galvanometer in the high voltage, D. C., circuit; with insulator supports for all connecting pipes and apparatus.

43. In a mechanism for the purpose described, an electrifier apparatus comprising a primary direct current metallic circuit of which the earth forms no part; with a manually operated circuit breaking switch in said circuit; in combination with a motor generator set and the like, to convert said primary D. C. to a primary A. C. of low frequency; with an adjustable step-up transformer to transform said primary A. C. to high voltage, A. C.; with a rotary converter and the like to convert said high voltage A. C. to a second high voltage D. C.; and in said second direct current supply circuit, with a manually changed pole changer switch to ground either pole lead of said circuit, and the other lead being thereby simultaneously automatically electrically connected with a conduit; and with an extension of said latter non-grounded lead wire into said conduit, said extension being of resistor material electrically heated; and with a rheostat, a ground, a voltmeter and an ammeter and a manually operated circuit breaking switch in the said second direct current circuit; with insulator supports for all apparatus.

44. In a mechanism for the purpose described, an electrifier apparatus comprising a primary direct current metallic circuit of which the earth forms no part; with a manually operated circuit breaking switch in said circuit; in combination with a motor generator set and the like, to convert said primary direct current to a primary alternating current supply of single phase and symmetrical; with a frequency converter to reduce the frequency of said primary A. C. to about 16 cycles per second; and with a double pole switch and connecting wires to connect such frequency converter in the primary A. C., circuit, with an adjustable step-up transformer to transform said primary A. C. to a second A. C. supply of high voltage; with a rotary converter and the like to convert said second A. C. to a second direct current supply of approximately like high voltage; and with a manually changed pole changer switch in the circuit of said second high voltage direct current supply, adjustable to ground either pole lead of said circuit, and the other lead being simultaneously thereby automatically electrically connected with a suitable conduit, with means of heating same, and with an extension of said latter lead wire into said conduit, such extension being electrically heated; and with a rheostat, a ground, a voltmeter, and an ammeter and a circuit breaking switch, in the said second direct current supply circuit; with insulator supports for all apparatus.

45. In an apparatus as described, a pulverizing mill on insulator supports, with non-conducting grind stones, with means of duly feeding thereto, the materials for grinding, and withdrawing therefrom the materials pulverized, under insulated conditions and under air-free conditions, and into a means for grounding therefrom electrons of one sign only.

46. In an apparatus as described, a pulverizer made of conductor material; with insulator supports; the conductor material being electrically connected with one pole of a D. C. supply circuit, the other pole being earthed.

47. In an apparatus as described, a pulverizer mill and the like; with insulator supports; with means of hermetically sealing and operating same; with means of passing therethrough a stream of a suitable gas under pressure to carry therefrom into connecting conduits the powdered materials; with means of electrically connecting the metal parts of the pulverizer to and in an A. C. circuit, with means of grounding either alternation thereof automatically.

48. In an apparatus for the purpose described, a U shaped retort tube and the like open at the ends, with a detachable hermetically sealed door between the ends to permit the insertion periodically of renewable loose material in the loop of the U without requiring supports therefor in the tube to keep the same in place when gases are violently forced therethrough; with means of hermetically joining the ends to connecting tube and apparatus for violently blowing gases therethrough, under pressure; with means for applying heat to the tube.

49. In the apparatus for the purpose described, a centrifugal powder and gas blower made of conductor material on insulator supports, with its metal revolving blades and frame electrically connected with a D. C. metallic circuit whereof one pole is earthed, with means of controlling the speed of the revolving blades, with means of passing powders and gases into and out of same through suitable connecting piping under insulated conditions and under air-tight conditions.

50. In an apparatus for the purpose de-

scribed, a metal centrifugal powder and gas blower with insulator supports; with its metal revolving blower blades and metal frame electrically connected with an A. C. metallic circuit whereof neither lead is grounded; with automatic means of earthing one alternation of each cycle of the alternating current; with means of passing, sucking and forcing powders and gases continuously into and out of the blower through suitable connecting piping, with means of externally heating the pipes for powders and the frame of the blower; all under insulated conditions and under air-tight conditions.

51. In a mechanism as described, a powder and gas blower twyer with insulator supports; with a propeller-like perforated blade fixed at and in its mouth, and electrically connected in series with an electric supply circuit whereof no part is grounded, and with means of automatically grounding either sign therefrom.

52. In an apparatus for the purpose described, a centrifugal powder and gas blower, with revolving arms; with insulator supports; in combination with means of electrifying the metal parts with one sign only, the opposite sign of the electric circuit supplying such being earthed; with means of heating the metal parts.

53. In the mechanism as described, an insulated injecting-jet nozzle, of resistor material, with insulator supports, and electrical connections from the nozzle, in series with an electrical circuit for heating same to high temperature, with means of bringing powders and gas in contact therewith during projection thereof, with means of electrically earthing thermal electrons emitted therefrom, as described.

54. In an apparatus as described, a means of separating powders, including dust, from gases, consisting of a U shaped tube, in a gas flue to a chimney and the like, in combination with a coarse dust-filtering mass loosely held in the loop of the U tube and without other support, and the mass having ample interstices and passage-ways for the flow of the gas therethrough; with a hermetically closed door and doorway in the U tube permitting the withdrawal of the mass and the powders intercepted thereby, and the renewal of the mass without removing the U tube from the flue.

In testimony whereof I have hereto affixed my hand in the presence of two witnesses.

JACOB E. BLOOM.

Witnesses:

ABR. I. SOLOMON,

EMMA BLOOM.